

**U. S. DEPARTMENT OF COMMERCE
CIVIL AERONAUTICS ADMINISTRATION
WASHINGTON, D. C.**



**Fundamentals
of Elementary Flight
Maneuvers**

Civil Aeronautics Bulletin No. 32

JUNE 1943

UNITED STATES DEPARTMENT OF COMMERCE
JESSE H. JONES, Secretary
CIVIL AERONAUTICS ADMINISTRATION
CHARLES I. STANTON, Administrator

Fundamentals of Elementary Flight Maneuvers

Civil Aeronautics Bulletin No. 32

JUNE 1943



UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1943

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.
Price 20 cents

TABLE OF CONTENTS

No.	Maneuver	Page
1.	Familiarization with the airplane.....	1
2.	Starting the engine.....	1
3.	Taxiing.....	5
4.	Effect of the controls.....	7
5.	Straight and level flight.....	9
6.	Turns.....	11
7.	Coordination exercises (elementary).....	13
8.	Normal climbs.....	15
9.	Normal glides.....	17
10.	Climbing turns.....	19
11.	Gliding turns.....	21
12.	Confidence building maneuvers.....	23
13.	Coordination exercises (advanced).....	25
14.	Series of stalls.....	27
15.	Rectangular course.....	31
16.	Take-offs.....	33
17.	90-degree approach.....	35
18.	Landings.....	37
19.	S-turns across a road.....	39
20.	180-degree side approach.....	41
21.	180-degree overhead approach.....	43
22.	Series of eights (elementary No. 1 and No. 2).....	45
23.	Forced landings on take-off.....	47
24.	90-degree forced landings.....	47
25.	180-degree forced landings.....	48
26.	Normal spins.....	49
27.	Accidental spins.....	51
28.	Cross-wind take-offs.....	53
29.	Steep turns.....	55
30.	Cross-wind landings.....	57
31.	Series of eights (elementary No. 3).....	59
32.	"Eights" around pylons.....	61
33.	"Eights" on pylons.....	63
34.	Series of turns.....	65
35.	720-degree steep turns (maximum bank).....	67
36.	Spirals.....	69
37.	Power landings.....	71
38.	Forward slips.....	73
39.	Side slips.....	74
40.	"Dragging" areas.....	75
41.	Check flights.....	77
42.	Questions.....	79

The Importance of Keeping a Notebook

Because it has been found that the average trainee has difficulty in retaining the myriad details which he must remember during flight instruction, it is recommended that you maintain a notebook and after each day's flight make an outline of the flight just completed, in which you should enter the details of the flight, your own impressions of your errors, and drawings of flight patterns. You should present this to your instructor who will make comments and suggest additions to the pertinent data you should retain. Prominent errors made during flight should be entered in the notebook either by you or your instructor.

One section of the notebook should be devoted to drawings of traffic patterns and a copy of airport rules supplied to you to insert in your notebook. Each maneuver should be entered in rough sketch and you should note, in your own words, the proper procedure for executing the maneuver.

ERRORS TODAY WILL BE HABITS TOMORROW IF NOT CORRECTED AT ONCE

Basic research and development work was conducted under the auspices of the Civil Aeronautics Administration-National Research Council Committee on Selection and Training of Aircraft Pilots. This research, and development work, extending over a period of approximately three years, was financed with funds provided by the Civil Aeronautics Administration. Actual preparation of the manual was the work of the Standards Division, War Training Service, Civil Aeronautics Administration.

FUNDAMENTALS OF ELEMENTARY FLIGHT MANEUVERS

TO THE TRAINEE:

This is the first of many similar sheets which your flight instructor will give you within the next few weeks—unforgettable weeks in which you will be learning how to fly. At the end of each lesson you will be given one or more of these sheets, describing the maneuvers which you are to take up in the next instructional lesson.

In no sense will these sheets take the place of your flight instructor. They should, however, be of real help, both to him and to you, in that you will be able to think over in advance—and even to practice in your imagination, the new maneuvers that you will learn in the next lesson. **Study these carefully.** Be sure that you know just what each maneuver is; just how it is executed; so that you can make the best possible use of the time you spend in the air with your instructor. If, however, anything about the maneuver is not clear, ask your instructor about it *before* you take off.

Neither are these sheets designed to take the place of the descriptions of each maneuver in your Civil Pilot Training Manual (Civil Aeronautics Bulletin No. 23; second edition).

Rather these are brief, concise, and simple explanations of each maneuver; things which your instructor can tell you, but which can be as well or better understood from written descriptions and diagrams such as these. Thus your instructor's time and energy, which are so valuable in these days, will be saved for those aspects of instruction which can take place only in the plane.

After studying each of these sheets, you are urged to read the parallel sections in the Civil Pilot Training Manual, where you will find a much more thorough discussion of each maneuver.

One can learn to fly without reading the manual, but he will find his flying is better, safer, and more enjoyable if he understands why an airplane behaves as it does under various conditions of flight.

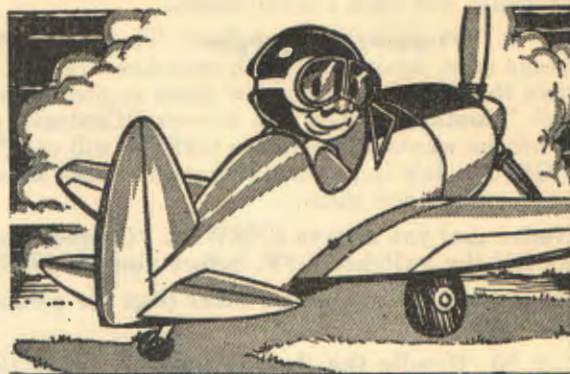
Keep each set of materials in order in a note-book, and you will find them of real help in "reviewing," and in improving your flying in the future. Your flight instructor will proceed with each lesson on the assumption that you have studied these materials thoroughly. He may even give you a short "quiz" on the maneuvers before taking off.

A GOOD PILOT IS ONE WHO KNOWS HE STILL HAS A LOT TO LEARN ABOUT FLYING

1. FAMILIARIZATION WITH THE AIRPLANE

Civil Aeronautics Bulletin No. 23; second edition. P. 242-243.

Now just sit in the plane and familiarize yourself with everything around you. Notice the position of the throttle and the switches. In most planes, they are to your left. Rest your feet on the rudder pedals and experiment with their action. Get the feel of the stick. Don't hesitate to sit there for 10 to 15 minutes. The inside of the plane should become as familiar to you as the inside of your car. Locate the instruments in their various positions on the instrument panel: The tachometer (R.P.M.'s), air-speed indicator, oil temperature, etc. **Note the full "ON" and "OFF" position of the Fuel Shut-Off Valve and Carburetor Heat Controls.** Your instructor will point them out to you and explain their functions. Don't



be afraid to ask questions. It would be a good idea to try to draw from memory, later, the various instruments in their correct positions.

2. STARTING THE ENGINE

Civil Aeronautics Bulletin No. 23; second edition. P. 58-66.

THIS IS THE PROCEDURE THAT YOU MUST ALWAYS FOLLOW WHEN YOU START THE ENGINE ON YOUR PLANE.

1. **Make sure that your plane is clear of other planes.** Head it so that it won't blow dust on spectators, other planes, or into the hangar. The dust and dirt raised by your propeller blast *can* damage other planes.

2. **Place blocks under the wheels.** It is dangerous for the plane to start moving when you are unprepared. Remember, too, that someone has to spin the propeller to start the engine for you, and that he will be in the path of the plane when the engine starts. Spinning the propeller by hand is called "propping." Always make sure that your plane is blocked (or "chocked") securely before starting the engine and also when you leave it after a flight.

3. **Run a line inspection of the airplane.** A line inspection is an inspection of the plane to see that it is airworthy. There are available printed check sheets (Form ACA 526) that list all points to be inspected (control cables, landing gear, spark plug connections, etc.).

Your instructor will explain this in more detail. Even though a line inspection may have already been run by someone else, do it yourself. You can't always count on having someone else do it for you—and he may not be as careful as you in checking, since he's not going to fly the plane.

4. **Check the gas and oil supply.** Never rely on the gas gages; they can, and often will, register incorrectly. Look in the tanks yourself. **Replace gas and oil tank caps securely.** An empty gas or oil tank is a miserable excuse for a forced landing—and it's a frequent reason.

5. **Fasten your safety belt as soon as you get in the plane. Make this a firm habit,** even if you're just going to warm up the engine. On the few occasions when you really need a belt, you don't have time to fasten it.

6. **Next, see that the Gas Shut-Off Valve is in the full ON position, that both the ignition switches are in the full OFF position, and that the throttle is fully closed (Pulled All the Way Back).**

7. **Never try to "prop" the engine yourself while attempting to handle the throttle at the same time.** Have some competent person, such as a mechanic, "prop" it for you. You

can't be in two places at once, and you certainly can't do a good job of both things. Civil Air Regulations require that a competent person must be in the plane at all times while the engine is running. **Don't violate a civil air regulation.**

8. **Keep the stick back, so that when the engine starts, the airplane's tail will stay on the ground.** Holding the stick back keeps the elevators raised, and the air stream from the propeller will force the tail down.

9. **"Propping" the engine:** The person "propping" the engine for you will call **"Off."** Make sure, again that both switches are Off, and answer **"Off."** Then he will probably turn the propeller over a few times to prime the engine (draw gas into the cylinders), and then call **"Contact."** You will answer **"Contact"** and then put the switches in the ON position. When he wants the switches **OFF**, he will call **"OFF."** You turn them **OFF** and then answer **"OFF."** It's important that you repeat all of his instructions so he can be sure that you have understood them.

Notice that you always ANSWER "Contact" before you turn the switches on; and you always TURN the switches OFF, before you ANSWER "OFF."

Do not talk to any person other than the person "propping" the engine for you while starting the engine.

10. **Handle the throttle gently.** While the engine is being turned over to start it, the throttle is kept closed. Sometimes, it is **very slightly** opened—this is called "cracking" the throttle. Just as the engine starts, open the throttle a little to "catch" it. With a little practice, you'll learn how to do this well and smoothly, so that the mechanic won't have to work too long to start your engine.

11. **Check the oil pressure immediately after the engine has started.** If the oil pressure gage does not register the correct pressure in a few seconds, stop the engine and have a mechanic locate the trouble.

12. **Warm up the engine at about 1000 R. P. M. or the proper speed for the particular engine on your plane.** This means that the propeller is rotating at the rate of 1000 *revolutions per minute* (R. P. M.) as indicated by the tachometer. At this speed, the oil pump is working efficiently and the propeller is blowing enough air past the cylinders to prevent the engine from overheating. You'll damage the engine if you run it at a higher speed before the oil has reached its proper operating temperature. Never let the engine idle (run with the throttle closed) for any length of time, because the propeller may not circulate enough air at this speed to cool the engine properly. It can overheat dangerously, under these conditions, before it registers on the oil temperature gage and warns you.

13. **Run your engine on each magneto separately for a check.** The engine on the plane has "twin ignition," or "dual ignition." This means that there are two spark plugs on each cylinder. Each set of spark plugs gets its spark from a separate magneto. There are usually two ignition switches in the plane—one for each magneto. (On many planes the two magnetos will be controlled by a single four-position switch marked: "OFF, Mag 1, Mag 2, BOTH"). When both magnetos are off, the engine stops.

If the full throttle engine R. P. M. on either magneto alone is 75 R. P. M. less than on both, something is wrong. Have the engine checked by one of the mechanics.

14. **After the engine warms up, hold the stick back and open the throttle fully, for a moment, to check if the engine is delivering maximum power.** Check the engine Idle R.P.M. Find out from your instructor what is the proper tachometer reading (R.P.M.) for your particular type of engine under these conditions. Check the other instruments, too: Oil temperature, oil pressure, carburetor heat, etc., to make sure that they register within the proper operating limits (ask your instructor about this).

Under certain conditions of ignition trouble causing engine failure during flight you will find that the engine will function normally on the good magneto turned on alone but when both magnetos are on, or the defective magneto on alone, the engine will not function normally. Remember this and if you ever encounter engine trouble during flight, First try the engine on each magneto separately, by switching from one magneto to the other and note any change in engine R. P. M.

Form ACA 528 (CPT-41)
(Rev. 8-19-40)DEPARTMENT OF COMMERCE
CIVIL AERONAUTICS ADMINISTRATION
WASHINGTON

Ident. Mark NC _____

DAILY FLIGHT INSPECTION RECORD

Date _____

PLANE _____ OPERATOR _____
(Make and model)*This form should be completed daily as indicated for each plane operated, and remain with the aircraft during the day's operations.*

Part I.—LINE INSPECTION

(Check column)

Complete before starting flight. Check satisfactory items; note others.

A. PROPELLER.

1. Inspect BLADES for pits, cracks, nicks _____
2. Inspect HUBS and ATTACHING PARTS for defects, tightness, and safetying _____
3. Check PROPELLER for track _____

B. ENGINE.

1. Inspect ENGINE COWLING for cracks and security _____
2. Inspect EXHAUST STACKS and COLLECTOR RING for cracks and security _____
3. Check VALVE-GEAR MECHANISM and LUBRICATE as necessary _____
4. Check SPARK PLUG TERMINAL ASSEMBLIES for cleanliness and tightness _____
5. Inspect accessible IGNITION WIRING and HARNESS for security of mounting _____
6. Clean main FUEL-LINE STRAINERS _____
7. Drain small quantity of fuel from bottom drain and inspect _____
8. Check FUEL and OIL SYSTEMS for leaks, vent openings, and fit of tank caps _____
9. Check FUEL and OIL supply (do not rely on gages) _____
10. Check all BOLTS and NUTS on engine and mount _____
11. Turn propeller; check COMPRESSION of CYLINDERS _____

C. LANDING GEAR.

1. Inspect TIRES for defects and proper inflation _____
2. Inspect WHEELS for cracks and distortion and HUB CAPS for security _____
3. Inspect SHOCK-ABSORBER UNITS and BRAKE-LINKAGE GEAR _____
4. Inspect STRUT-RETAINING BOLTS and FITTINGS for security _____
5. Inspect BRACE WIRES for tension and security _____
6. Inspect MAIN FLOAT(S) for leaks and security of hand-hole covers _____

D. WINGS.

1. Inspect COVERING for damage, buckled ribs, and end bows _____
2. Inspect ATTACHMENT FITTINGS for security _____
3. Check STRUTS and FLYING WIRES for security of terminal connections _____
4. Check AILERON HINGES, PINS, HORNS, and TABS _____
5. Inspect accessible CONTROL CABLE, TUBES, and PULLEYS for security _____

E. TAIL CONTROL SURFACES.

1. Inspect COVERING for damage, buckled ribs, and bruised edges _____
2. Inspect ATTACHMENT FITTINGS for security _____
3. Check STRUTS and BRACE WIRES for security of terminal connections _____
4. Check CONTROL-SURFACE HINGES, PINS, HORNS, and TABS _____
5. Inspect CONTROL CABLE, TUBES, and PULLEYS for security and lubrication _____
6. Check STABILIZER ADJUSTMENT assembly mechanism _____
7. Check TAIL SKID or WHEEL assembly for condition and lubrication _____

F. FUSELAGE.

1. Inspect COVERING for damage and distortion _____
2. Inspect CONTROL COLUMN assembly and accessible parts of control system for freedom of movement, security of attachments _____
3. Inspect RUDDER PEDAL assembly and CONTROL SYSTEM as above _____
4. Check STABILIZER ADJUSTMENT mechanism for freedom of movement _____
5. Locate FIRE EXTINGUISHER and FIRST-AID KIT _____
6. Inspect all removable COWLING, FAIRING, and INSPECTION PLATES for security _____
7. Check proper functioning of LIGHTING SYSTEM _____
8. Inspect for security of SAFETY BELTS _____
9. Check functioning of ENCLOSURES and ADJUSTABLE-SEAT mechanism _____

G. WARMING UP.

1. See that CHOCKS are under wheels.....
2. Warm up and check proper functioning of ENGINE.....
3. Test engine(s) on each MAGNETO and on all TANKS.....
4. Check ENGINE CONTROLS for proper functioning and lost motion.....
5. Check position of CARBURETOR AIR PREHEATER.....
6. Check operation of CARBURETOR MIXTURE CONTROL.....
7. Check RADIO EQUIPMENT for proper functioning.....
8. Oil temperature..... Oil pressure..... R. P. M..... Am't fuel..... Am't oil.....
9. Engine idle R.P.M.....

I CERTIFY that above airplane has this day been inspected under my supervision as above indicated and that the aircraft is (is not) ready for flight.

Signed: _____
(Student) *Supervisor of Inspection.* _____ (Certificate number)

Part II.—SERVICING RECORD

Complete as necessary during and at finish of flight operations.

	1st	2d	3d	4th	5th
Gallons of gas.....					
Quarts of oil.....					

Part III.—REPORT AFTER FLIGHT

To be completed by each student after each flight.

Flight No.	Average r. p. m.	Air time	REMARKS	Student's last name	Cash or credit
			During flight I have noticed the following defects in this plane which should be remedied:		
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Total time.....	Total gallons of gas.....	Total quarts of oil.....
Previous time this month.....	Previous gallons this month.....	Previous quarts this month.....
Total this month.....	Total this month.....	Total this month.....
Total time since check:	Total time since overhaul:	Time since oil change:

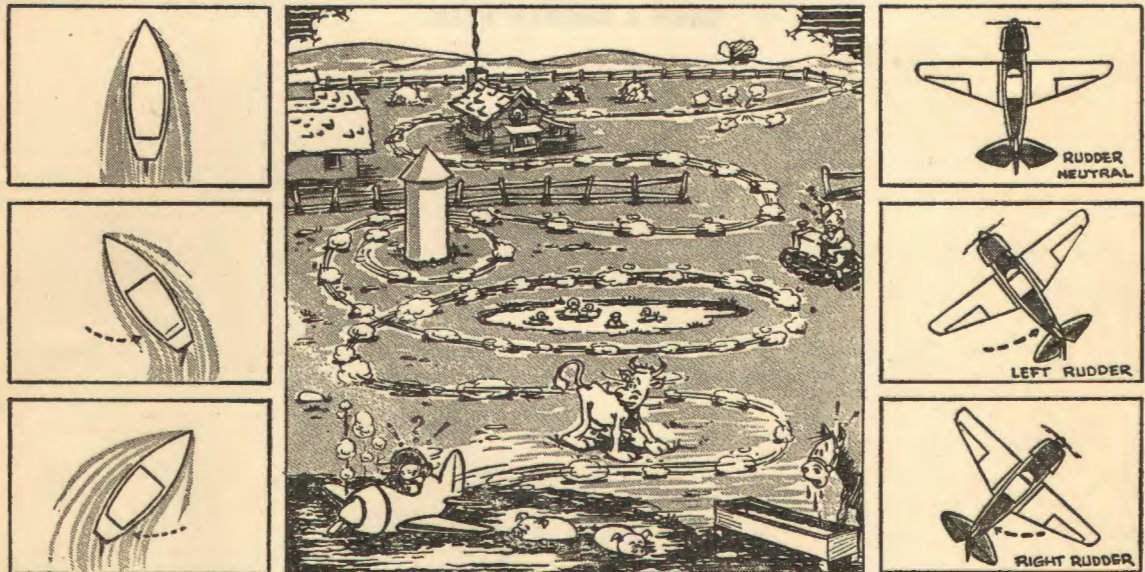
3. TAXIING

Civil Aeronautics Bulletin No. 23; second edition. P. 105-113.

When taxiing, look for other airplanes and ground obstructions! Your visibility is extremely limited when on the ground. Be careful that the blast of air from your propeller (the "prop-blast") doesn't blow dust on spectators, or endanger other airplanes on the ground behind you.

The rudder is the most important control when taxiing. The plane's movements are controlled by the pressure of the air as it moves past the control surfaces of the plane (the elevators, rudder, and ailerons). On the ground, most of the pressure on the controls is exerted by the streams of air from the propeller. Thus the ailerons are ineffective since the "prop-blast" does not reach them. Furthermore, since the plane is not moving through the air and the "prop-blast" alone affects the controls, you will find that you need a much greater movement of the rudder pedals to maneuver the plane than you do when the plane is flying.

While taxiing follow an "S"-shaped course from time to time so that you can see what is directly ahead of the plane. If there is danger of collision, turn off the switches. A revolving propeller causes more damage than a still one.



If your training plane has a steerable tail-wheel, the rudder control will be rather stiff while the plane is on the ground. More pressure but less movement of the rudder pedals will be used in taxiing than if directional control is dependent on the rudder alone.

If the plane has brakes, they are used to control the plane when it is moving *slowly* on the ground. The brake pedals are usually located just below the rudder pedals, and are operated with your heels. To stop, both right and left brakes are pressed **simultaneously**. To turn right, the right brake is used. To turn left, the left brake is used.

All pressure should be applied gently. Never use your brakes when taking off or landing. (Unless in an emergency.) Never turn with one wheel stationary.

Keep your tail down while taxiing. In taxiing, the stick is used to keep the tail on the ground. When taxiing into the wind (up wind) the elevators should be raised (by holding the stick back) so that a sudden gust of the wind will serve only to hold the tail on the ground. When taxiing with the wind (down wind) the elevators should be lowered (by holding the stick forward) so that a sudden gust of wind from behind the airplane will force the tail down.

When taxiing into the wind (Up Wind), keep the stick back of neutral.

When taxiing with the wind (Down Wind) keep the stick forward of neutral.

Use the throttle gently. In taxiing, the engine should be kept running only fast enough to keep the plane moving slowly, about as fast as you could walk across the ground. When the plane is at rest, it is necessary to increase the engine R. P. M. to start the plane moving, but once it is rolling, the engine R. P. M. should be reduced. Rest your hand lightly on the throttle at all times.

Before taking off, check the air and ground in all directions for incoming traffic by making a complete turn to the right. Incoming traffic circles to the left around the field. By turning to the right you get the best possible view of the approaches to the field. Landing airplanes have the right of way. If, as you check your traffic, you see a plane approaching, turn your plane facing the traffic as a signal to the pilot who is landing that you intend to wait for him to land. (If your field rules are such that incoming traffic circles to the right, your turn on the ground before take-off should be to the left.)

Thoroughly familiarize yourself with local field rules and traffic patterns. After landing, make a complete turn to the left or right (according to local field rules) and check for air and ground traffic before taxiing back to take off, or up to the hangar.

MAKE IT A RULE TO LOOK IN ALL DIRECTIONS WHEN TAXIING—A STIFF NECK IS BETTER THAN A BROKEN NECK

4. EFFECT OF THE CONTROLS

Civil Aeronautics Bulletin No. 23; second edition. P. 15-16.

To appreciate fully the effect of the controls, make sure you are seated comfortably in the plane and that you can operate all the controls to their fullest extent. When the airplane is in level flight, the control surfaces (the ailerons, elevators, and rudder) tend to "streamline" themselves with the surfaces to which they are attached. That is, due to the pressure of the air flowing over them, the ailerons will lie flush with (or in the same plane as) the stabilizer, and the rudder will lie flush with the vertical tail fin. Therefore, with the plane in level flight, the stick and rudder will assume the "neutral" position, even if the pilot takes his hands and feet off the controls.

The plane is maneuvered by moving these control surfaces out of this streamlined neutral position. This is done by exerting pressure on the controls (the stick and rudder pedals), moving them away from the neutral position. Hold the stick between the thumb and fingers of your right hand, and rest the balls of your feet on the rudder pedals, with your heels on the floor.

The plane is maneuvered by exerting steady pressure on the controls, never by quick rough movements.

Think of yourself as the point around which the plane pivots when maneuvered.

Forward pressure on the stick pushes the nose of the plane away from you, or toward the landing gear. Back pressure on the stick pulls the nose of the plane toward your head.

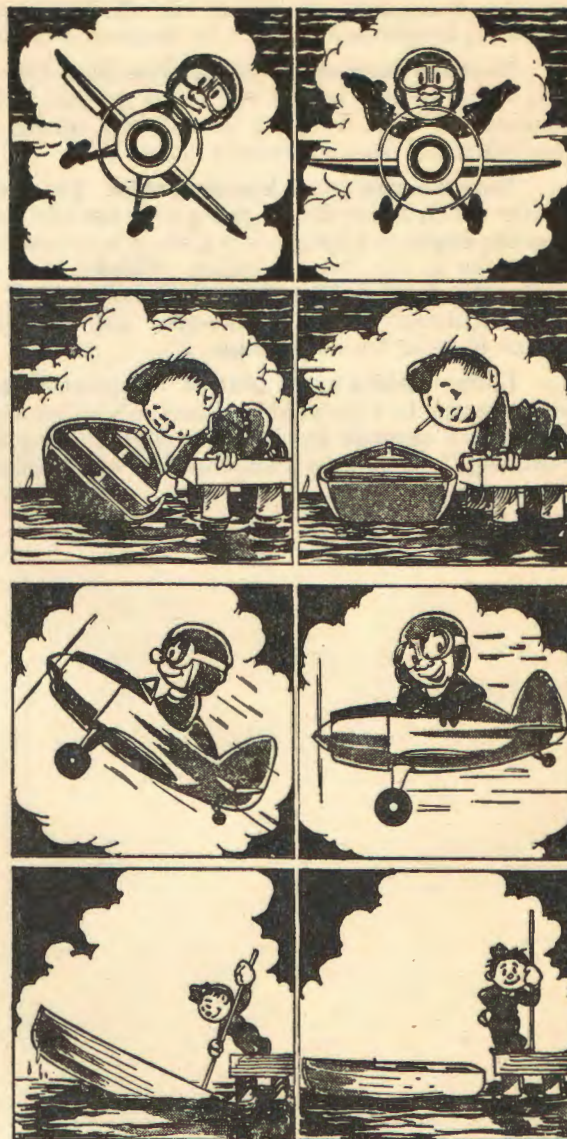
Side pressure on the stick causes the plane to roll or bank in the direction of the pressure. That is, pressure on the stick to the right lowers the right wing and raises the left wing. Pressure on the stick to the left lowers the left wing and raises the right wing.

Pressure on the rudder pedal causes the nose of the plane to swing in the direction of the pressure, therefore, right rudder pressure causes the nose of the plane to swing toward the right wing tip. Left rudder pressure has the opposite effect.

These relationships hold irrespective of the position of the plane in relation to the horizon or ground.

The throttle is the control which regulates the amount of fuel going to your engine. It should be handled gently, since sudden movements of this control put undue loads on the engine or flood it with gas. Learn to fly with your hand on the throttle at all times so that you can use it promptly in case of emergency.

The stabilizer control, usually a crank is used to adjust the fore and aft balance of the plane. If the plane tends to be "nose-heavy", crank the stabilizer control back (or counter



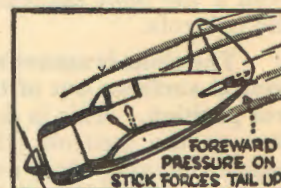
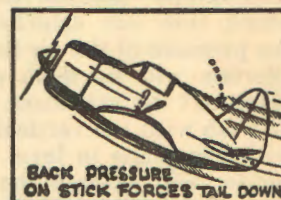
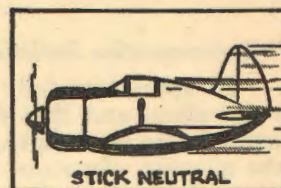
clockwise). This holds the nose in a higher position. If the plane tends to be "tail-heavy" crank the stabilizer control forward (or clockwise) until the plane flies level without forward or back pressure being exerted on the stick.

Note the position of the magneto switches. The engine should be able to operate on either one of the magnetos. Normally, of course, it is operated on both for maximum efficiency and safety.

Note the position of the gasoline Shut-Off valve. Always check this valve before taking off, to be certain it is in the FULL ON position. Check it again occasionally during flight, to make sure that vibration hasn't partially closed it.

Note the carburetor heater control. This turns on the carburetor heater which heats the air going into the carburetor intake. Whenever the engine is idling as in a glide, it is necessary that the carburetor heater be in the "on" position. **"Make it a rule to turn on your carburetor heat before closing your throttle."** Some engines also need carburetor heat on take-off. Ask your instructor about the engine in your training plane.

Under certain conditions of temperature and humidity it may be necessary to turn your carburetor heat on **several minutes** before closing the throttle to eliminate engine idling too slow and possible "quitting," caused by condensation of moisture or ice forming in the carburetor.



5. STRAIGHT AND LEVEL FLIGHT

Civil Aeronautics Bulletin No. 23; second edition. P. 118-121.

Straight and level flying is one of the fundamental maneuvers, and in certain respects, one of the most difficult. Flying straight and level means, of course, that the plane is flying horizontally, with the wings level, and in a straight line across the ground. Later on, the straight and level attitude of your plane will be "sensed." At first, however, keeping the plane flying straight and level is a matter of a number of mechanical adjustments.

Your instructor will demonstrate straight and level flight *at cruising speed*, since the relationships are not the same at other speeds.

Note the position of the nose of the plane in relation to the horizon. Usually it is possible to pick out some reference point on the nose of the plane (a cylinder, the gas cap, etc.) which is even with the horizon when the plane is flying level. During the demonstration, find some reference point on the plane or engine that seems to be on the horizon *to you in your position*, when flying straight and level.

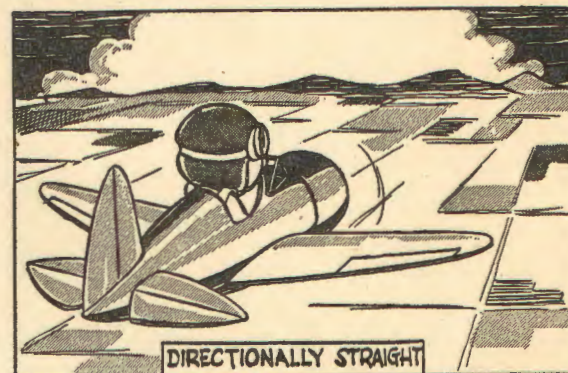
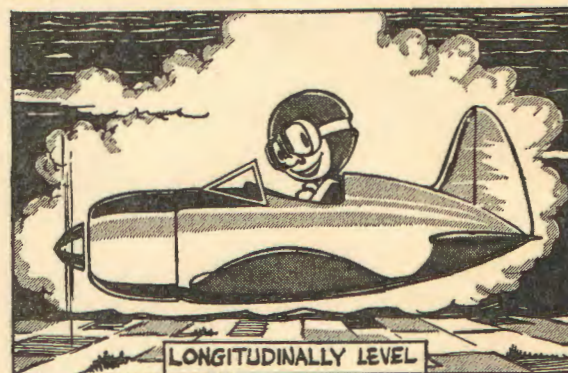
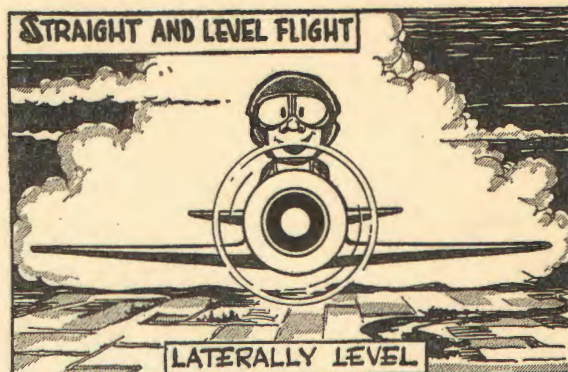
Note that the under side of the wing tip seems to form a line. When this line is parallel with the horizon you are flying level.

Look out of both sides of the plane and note that there is the same amount of sky under each wing tip. This indicates that your wings are level.

To maintain a straight path over the ground, pick out a landmark on your line of flight, and fly toward it. As you reach the first landmark, pick out another still farther on, and fly toward it. In still air, little or no pressure on the controls should be necessary when flying straight and level. "Trim" your plane by adjusting the stabilizer control so the plane flies level without pressure on the stick.

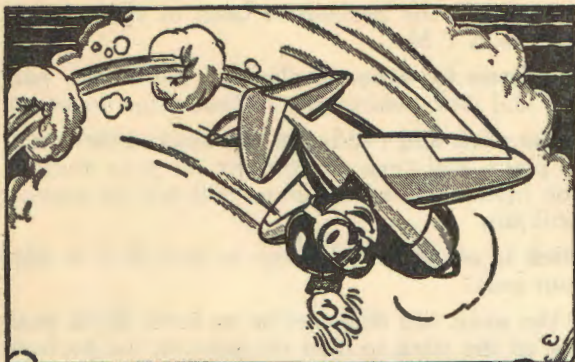
Don't fight the controls. If a sudden gust of air blows the plane off its straight and level flight, it will return to straight and level flight of its own accord eventually. However, by gently coordinated pressure on the controls, you can speed up its return to straight and level flight. But don't be in too much of a hurry to make it do what it wants to do anyway.

Be careful that you don't let either wing "droop." You may tend to fly with your right wing low. Since you control the stick with your right hand, you may have a tendency to hold the stick slightly to the right. A helpful practice exercise to overcome this tendency follows: Sit in the plane on the ground. Keep your eye on the ailerons, and practice pulling the stick back. You should be able to pull the stick back, consistently, without moving the ailerons.



6. TURNS

Civil Aeronautics Bulletin No. 23; second edition. P. 121-135.



Suppose you are in an automobile. If you make a turn too fast on a flat road there is a tendency for the car to skid outward. Even if you made a sharp turn fairly slowly, this tendency to skid would be evident. However, if the road were banked the correct amount (the degree of bank depending upon the speed of the car, and the sharpness of the turn), this tendency would be eliminated. Similarly, if a car made a turn which was banked **too steeply** it would have a tendency to slip down toward the inside of a turn.

Instead of an airplane flying along a road which is banked, the pilot banks the plane itself, by side pressure on the stick. At the same time he determines his rate of pressure on the rudder, and by back pressure on the stick. Thus, whether he slips or skids depends on whether or not his pressures on the controls are coordinated. If these control pressures are coordinated, he will have just the right amount of bank for his rate of turn.

A Note on Coordination:

The term "Coordination" (or "coordination pressure," "coordinated controls," etc.) is one which you will meet frequently in flying. Therefore it is important that you understand clearly what it means. **Coordinated pressure on the controls merely means that pressures are applied to one or more controls simultaneously, or in sequence, in such a manner that the plane does EXACTLY what you want it to do.**

Coordination is important in all maneuvers, but in your elementary flight training you will hear it referred to more often in regard to turns than in regard to any other maneuver. This is because most of the maneuvers in your primary training are combinations of turns.

Good coordination in a turn requires that pressures be applied to stick and rudder in such a manner that the plane neither skids nor slips. Since in your turns your air speed will be fairly constant, the excellence of your turn depends upon how well your rate of turn and amount of bank are adjusted to each other. The pressures on the controls used in making a turn will be discussed shortly.

You will probably wonder how you can tell if you skid or slip in a turn. The explanation is simple. During a turn, the same forces acting on the plane that cause it to skid and slip are acting on you, the pilot. If the plane skids, you will tend to slide over **toward the edge of the seat that is on the outside of the turn**. If the plane slips, you will tend to slide over toward the edge of the seat that is on the **inside of the turn**. In a good turn, neither of these tendencies will be evident. You will merely feel as if you were being pushed down into the seat. (This results from the centrifugal force that is developed.)

Remember, and this is important, these forces which act on the ship will act on you only if you are "riding with the plane." Therefore, don't lean away from the bank, or attempt to keep your body perpendicular to the horizon. Relax and try to feel the effect of pressures on the weight of your body.

You can't detect skids or slips unless you are "Riding With the Plane."

An even better indicator of skids or slips is a "Ball Bank" instrument, mounted on the instrument panel. This consists of a metal ball resting loosely inside a slightly curved glass tube. In a slip or skid, the ball rolls to one side or the other from its normal central position and thus permits the pilot to "see" as well as "feel" a skid or slip. Such an instrument is more sensitive than "seat sense" of even a good pilot and hence is extremely useful in perfecting your coordination. Do not, however, rely solely on this instrument. You will probably fly some airplanes not so equipped and need to be able to detect slips and skids without it.

Right now you will be concerned with medium banked, and gentle banked turns. A medium banked turn is one in which the angle of bank is between 30 and 50 degrees. In a gentle banked turn, the angle of bank is less than 30 degrees. Your instructor will demonstrate the correct relationship of the lowered wing with the horizon in both of these turns. Both of these maneuvers are done at cruising engine R.P.M.

Before you turn, check the air on all sides of you for other airplanes. Note with particular care the area in which you will be turning, and look behind you in that same direction.

To make a turn, apply coordinated pressure on stick and rudder in the desired direction. If you apply too much rudder the nose of the plane will turn too rapidly for your angle of bank, and the plane will skid. If you apply too little rudder, the plane will not be turning enough for your angle of bank, and the plane will slip.

Coordination of pressure on rudder and stick is essential. Whenever you skid or slip, it is a direct result of lack of coordination on your part.

Just as the plane starts to bank and turn, the nose will drop below its level flight position. You will have to exert some back pressure on the stick to hold the nose on the horizon, and prevent loss of altitude. For a detailed discussion of why this back pressure is needed, see Civil Aeronautics Bulletin No. 23; second edition. P. 122-123.

After the bank and turn is established, relax your pressure on the rudder and ailerons, and return them to neutral, at the same time holding enough back pressure on the elevators to keep the nose on the horizon and prevent loss of altitude.

You will then have to hold just enough opposite aileron (i. e., opposite to the direction of the bank) to prevent your bank from becoming steeper. That is, you must compensate for the "overbanking tendency" of the airplane, which results from the fact that the wing on the outside of the turn is going faster, and therefore has more lift than the inside wing.

To come out of a turn, apply coordinated rudder and aileron pressure in the opposite direction to the turn, and gradually release the back pressure as the wings become level. Again, the rudder and aileron pressure must be coordinated, and the back pressure released so that the nose of the plane remains level. You will have to start to recover from the turn slightly before the plane heads in the desired new direction, since it continues turning during the recovery process.

Remember: Coordinate your rudder, aileron, and elevator pressure. Ride with the airplane during the turn. Don't lean away from the bank. After the bank and turn is established, release rudder and aileron pressure, and then apply enough aileron and elevator pressure to maintain a constant bank and altitude. **Don't** get the nose of the plane too high in a turn, the plane will stall at a higher speed in a turn than in straight and level flight.

KEEP FLYING SPEED AT ALL TIMES

7. COORDINATION EXERCISES (ELEMENTARY)

Civil Aeronautics Bulletin No. 23; second edition. P. 136-138.

Coordination of the controls is very important, especially in turns. It's a good idea to practice coordination whenever you can. Here is an exercise which will do much to increase your flying skill.

Alternating banks and turns in level flight:

Before you turn, check the air on all sides and to the rear of you for other planes, particularly the area in which you will be turning.

Start a medium banked turn in either direction, and turn through an arc of 90 degrees. Then roll the plane out of this turn, fly straight and level for a moment, and proceed to make a turn in the other direction.

Keep your bank about 30 degrees—keep it constant during the turn.

Keep the nose of your plane at a position on the horizon that will prevent loss of altitude.

Keep all the movements smooth and well-coordinated. You'll soon discover the deep satisfaction that comes with smooth maneuvering and good coordination.



SIT RELAXED AND RIDE WITH THE PLANE AND TRY TO "FEEL" YOUR COORDINATED CONTROL PRESSURES.

7. COORDINATION EXERCISES (ELEMENTARY)

Copyright 1917 by The McGraw-Hill Companies, Inc.

Coordination of the muscles is very important, especially in the hands. It is the basis of all skillful work. It is the basis of all art. It is the basis of all science. It is the basis of all life.

The following exercises are designed to develop the hands.

1. Place your hands on the table, palms down. Spread your fingers as wide as possible. Now bring your fingers together. Repeat this ten times.

2. Place your hands on the table, palms down. Spread your fingers as wide as possible. Now bring your fingers together. Repeat this ten times.

3. Place your hands on the table, palms down. Spread your fingers as wide as possible. Now bring your fingers together. Repeat this ten times.

4. Place your hands on the table, palms down. Spread your fingers as wide as possible. Now bring your fingers together. Repeat this ten times.



THESE EXERCISES ARE DESIGNED TO DEVELOP THE HANDS. THEY ARE NOT TO BE USED AS A SUBSTITUTE FOR THE HANDS. THEY ARE TO BE USED AS A SUPPLEMENT TO THE HANDS.

8. NORMAL CLIMBS

Civil Aeronautics Bulletin No. 23; second edition. P. 152-154.

Before you start a normal climb, make sure that the air ahead and above is clear of other planes.

To start a normal climb, increase your engine R. P. M. about 100 above cruising. Then raise the nose of the plane so that it is slightly higher than in straight and level flight.

Don't raise the nose abruptly; always move your controls smoothly. You will notice that, in the climb, your engine speed will drop back to cruising. This is because the engine has more work to do.

The proper attitude of the airplane in a normal climb will be shown to you by your instructor. Find some reference point on the plane, such as a cylinder, which is even with the horizon in the climb. This can be a useful guide to you later on in estimating if your climb is normal.

Many things affect the climb. Although we speak of a "normal climb" it is important to realize that the performance of the plane in a climb is affected by weight of the plane, condition of the motor, temperature of the air, altitude, and other factors! If in doubt, climb less steeply than in a normal climb!

If your engine seems to be working too hard, or vibrating more than usual, you are climbing too steeply. Remember that the engine has more work to do in a climb; the steeper the climb, the more work it has to do.

For any given set of conditions there is one climbing angle at which the plane gains altitude most rapidly. If you try to climb more steeply than this, the plane will "mush" and, although you seem to be climbing steeply, you actually gain altitude less rapidly. If you continue to climb too steeply, the airspeed becomes less and less, and eventually the plane is not moving fast enough through the air to maintain flight, and a stall (to be taken up later) will result.

To recover from a normal climb, release the back pressure on the stick to lower the nose to level flight position. When you do this, you'll notice that the engine R. P. M. increases, so you must throttle back to cruising engine R. P. M.

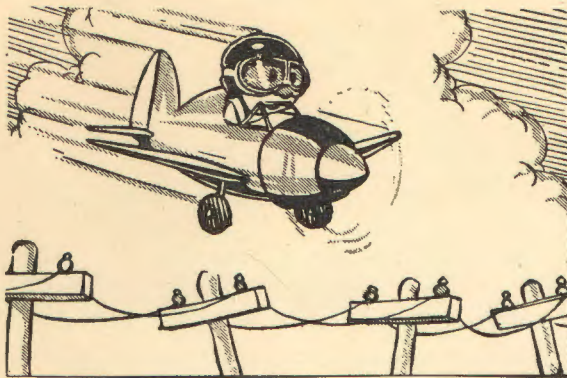
THE MAXIMUM CLIMB

A maximum climb is executed in the same way, except that full throttle is used. As a result, your angle of climb can be slightly steeper.



9. NORMAL GLIDES

Civil Aeronautics Bulletin No. 23; second edition. P. 154-157.



A **normal glide** is a glide at an angle and speed that will give the greatest distance forward for a given loss of altitude in still air. It is important that the trainee be able to recognize and maintain a normal glide.

In all approaches to a landing, the glide must be normal and constant for good results. For instance, if the glide is too fast the plane will glide a considerable distance just above the ground before the excess speed is dissipated and it can land. However, if the gliding speed is slower than normal gliding speed, the plane settles more rapidly and the gliding distance is shortened. If the speed is decreased any more, danger enters in as the stalling speed of the plane is reached.

For the first few hours of your training, you will be allowed to watch the airspeed indicator and keep the glide normal and constant by referring to it. After you are familiar with a normal glide, you should not depend on the airspeed indicator exclusively but sense the plane's attitude and speed. This is done by noting the position of the nose on the horizon, the angle formed between the wing and the horizon, the feel of the controls, and the sound of the air past the plane. You will get experience in this while the instructor is demonstrating a normal glide and while you are practicing them using the airspeed indicator.

In a gliding attitude, the nose of most training planes will cover the intended flight path of the plane. Therefore it is important to be sure there are no other planes in the way before the glide is started.

To begin the glide, the throttle is slowly and smoothly closed and the nose lowered slightly by exerting slight forward pressure on the stick. When the nose is set at the proper position, which will be demonstrated, release the forward pressure on the stick and apply enough back pressure to keep the speed normal and the nose in this position.

About every 20 seconds during the glide the throttle should be opened slowly and smoothly about a third of the way and then closed again. This will clear out the excess gas in the engine which might cause it to choke up and quit running. To recover from the glide, the throttle is opened smoothly to cruising engine R. P. M. and back pressure is released so that the nose of the plane remains in level flight position.

REMEMBER: TURN CARBURETOR HEAT ON BEFORE CLOSING THROTTLE.

10. CLIMBING TURNS

Civil Aeronautics Bulletin No. 23; second edition. P. 183-184.

A shallow climbing turn is simply a gentle turn made while the airplane is climbing. Thus, in making a climbing turn, combine the principles you learned when you practiced normal climbs and normal turns.

As in all turns, coordination of your controls is important. You will find it necessary to hold more back pressure in a climbing turn than in a normal turn, since the nose is already held in a climbing position.

Remember: In a *climb*, the air speed of the plane decreases. In a *turn* your minimum safe flying speed becomes greater. Thus, in a **climbing turn**, your margin of safety above this minimum flying speed is less than during either a normal climb or a normal turn.

Therefore: With the same amount of power, the same degree of climb cannot be maintained in a climbing turn as in a straight climb.

Decrease the angle of climb before starting the turn.

Make a shallow banked turn.

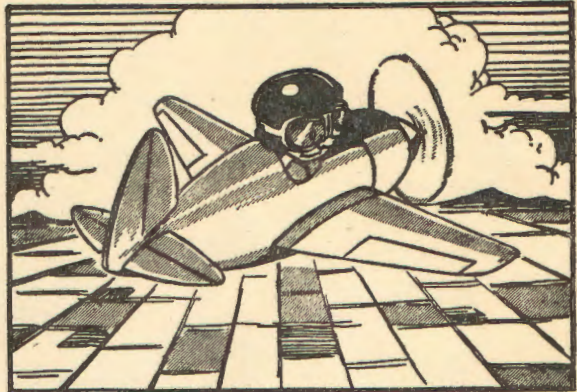
Coordinate your controls. If you don't use enough rudder for your angle of bank you will climb with one wing low and "slip." Too much rudder for your angle of bank results in a skid, and a resultant loss of air speed.

A skid in a climbing turn is dangerous. It may develop into a spin.

To recover from a climbing turn, coordinate opposite rudder and aileron pressure. At the same time ease off your additional back pressure so that, by the time the plane is flying straight, you are back in a normal climb.

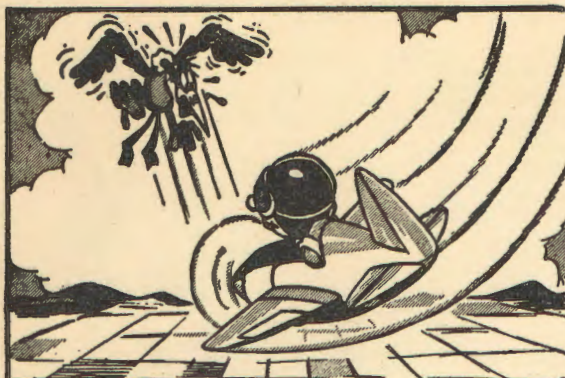
A **maximum climbing turn** is executed similarly to a shallow climbing turn, except that it is done at full throttle so that your angle of climb can be slightly steeper. In maximum climbing turns, your bank should be less than in a shallow climbing turn. In general, the steeper the climb, the shallower should be your bank in a turn.

The recovery is the same as from a normal climbing turn, except that when you come out of the turn you should be back in a maximum climb.



11. GLIDING TURNS

Civil Aeronautics Bulletin No. 23; second edition. P. 155.



turn. As usual, coordinated rudder and aileron pressure must be given in the direction you wish to turn. Your bank should be medium.

Control pressures are only slightly different in a gliding turn than in a turn with power. More back pressure is needed after the bank has been established, since you already will be exerting back pressure to hold the plane in a normal glide. **You may notice that the resistance of the controls, particularly the rudder, is less than in flight with power on.** This follows from the fact that there is no slip stream from the propeller to blow on the rudder during the gliding turn.

The plane will recover more quickly than it did when you recovered from a turn with power. In a turn with power, you must start your recovery somewhat before the plane has turned the desired amount. In a gliding turn, the plane stops turning almost as soon as you start your recovery.

WATCH YOUR COORDINATION. A SKID IN A GLIDING TURN MAY DEVELOP INTO A SPIN.

KEEP YOUR NOSE DOWN IN GLIDING TURNS. ALWAYS KEEP FLYING SPEED.

FLY THE AIRPLANE; DON'T JUST MECHANICALLY MOVE THE CONTROLS AND LET THE AIRPLANE FLY YOU.

As in all glides, remember to clear the engine about every twenty seconds, by opening the throttle to cruising R. P. M. Apply carburetor heat before closing the throttle.

A turn which is made during a normal glide is called a gliding turn. Since it is generally used in approaches for landings, this maneuver is often executed near the ground. More attention must be given to the degree of bank, and turn, position of the nose, speed of the plane, and also to the difference of control pressure, as compared with turns with power on. Therefore, it is particularly important that it be done correctly.

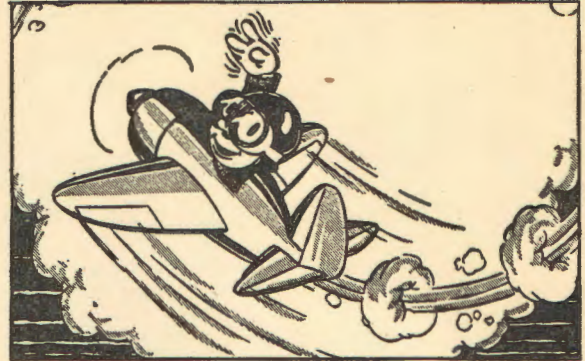
Before starting your turn, look in all directions for other airplanes.

Then lower your nose below the normal glide position to pick up speed, and start your glide up speed, and start your pressure must be given in the direction you

12. CONFIDENCE-BUILDING MANEUVERS

Civil Aeronautics Bulletin No. 23; second edition. P. 138-140.

By this time, you may have the idea that an airplane is a pretty complicated mechanism to handle, and that it must be carefully watched to keep it behaving properly. These confidence maneuvers are designed to show you that the **plane can take care of itself**, if necessary, very nicely. Many times, when you use the controls to place the plane in a certain attitude, you are merely helping it to do what it would anyway.



In this instruction flight, your instructor will climb the plane to about 1,000 feet. There, he will place the plane in level flight position. Then both you and he will remove your hands and feet from the controls. You'll see how the plane flies straight and level fairly well with no one controlling. If a wing drops a little, the plane will slip toward the low wing, and **the plane will tend to right itself**.

The plane will recover from a bank and turn by itself. This will be demonstrated by putting the plane in a medium bank and releasing all the controls. The nose will immediately drop a little and the plane will slip toward the low wing, but after a short time will return to level flight.

After this, your instructor will fly the plane straight and level and then close the throttle to idling position. You will notice that the nose of the plane drops a little and dives slightly. In other words, the plane is nose heavy. This characteristic is built into the airplane as a safety measure. If the plane is allowed to fly "hands-off", it will dive until it gains enough speed to raise the nose to level flight again. However, the plane can be trimmed to glide "hands-off" by adjusting the stabilizer control until no pressure is required on the stick to hold the plane in a glide.

The final maneuvers will demonstrate the overlapping functions of the controls. They show how the controls can be used in an emergency. First, your instructor will show how a turn can be made using only the elevators and rudder. He'll apply only rudder, causing the plane to start a flat skidding turn. In the turn, the outside wing is traveling through the air faster than the inside wing. This gives it more lift, so it goes up, putting the plane in a bank. Just as in any turn, the instructor will apply back pressure as the bank progresses. When the rudder is released and opposite aileron is applied, the plane will return to straight and level flight.

Your instructor will demonstrate the same maneuver using only the ailerons and elevators. As he applies pressure to the stick, the plane will bank and start slipping toward the low wing. This causes air to strike against the vertical fin and rudder surfaces, turning the plane. When aileron pressure in the opposite direction is applied, the plane will slowly return to straight and level flight.

You will notice in entering a turn that the plane skids when the rudder alone is used, and it slips when the ailerons alone are used. The reverse holds true in recovering from a turn.

Although a turn can be accomplished by using the rudder or ailerons only, you can see that no precision will result. This emphasizes the importance of coordination of control pressures in all maneuvers, i. e., the right combination and sequence of pressure on the controls.

There is no reason for alarm when the instructor demonstrates these maneuvers. Modern airplanes have an amazing amount of stability built into them; in fact your plane will "fly itself" better than most trainees can fly it during their first few hours of instruction!

13. COORDINATION EXERCISES (ADVANCED)

Civil Aeronautics Bulletin No. 23; second edition. P. 183.

You have already had one coordination exercise. Here are some more that are essentially similar to the first one, but slightly advanced. Practice them whenever you have the opportunity.

Alternating Banks and Turns While Climbing:

Before you turn, check the air on all sides and to the rear of you for other planes, particularly the area in which you will be turning.

Start a shallow banked climbing turn in either direction, and turn through an arc of 90 degrees. Then recover from the turn, climb straight for a moment, and proceed to make a climbing turn in the other direction.

Remember to increase your throttle setting 100 engine R. P. M.'s above cruising for the climb.

Remember, the minimum safe air speed in a turn is greater than in level flight, so: Reduce your angle of climb to slightly below that for normal climb. Make your banks shallow.

Alternating Banks and Turns While Gliding:

This is the same as the preceding exercise, except that it is done while gliding.

Start this exercise at about 2,000 feet or higher. Lower the nose of the plane slightly below the normal glide position before starting. This will provide the extra margin of airspeed needed for safety in the turns. Keep your airspeed constant.

REMEMBER: BEFORE YOU TURN, CHECK THE AIR ON ALL SIDES AND BELOW, PARTICULARLY THE AREA IN WHICH YOU WILL BE TURNING.

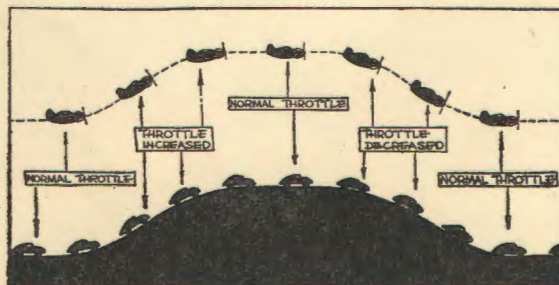
Alternating Climbing and Gliding Turns:

Another excellent coordination exercise is one that combines the principles of the two preceding ones. It consists of alternating climbing and gliding turns, in alternating directions. You can start, for example, with a climbing turn to the right through an arc of 180 degrees. Follow this with a gliding turn to the left of 180 degrees. Then execute another climbing turn to the right, and so on. The turns are made through 180 degrees in this maneuver, since it is more complicated than the others. This gives you more time to keep track of what's going on.

Start this exercise at altitude of 800 to 1,000 feet. It's a good idea to practice along a road or some other straight landmark to get an idea of how the maneuver progresses. At first, choose a road that is parallel to the wind direction. After you become more skillful, you can use a road that is cross-wind.

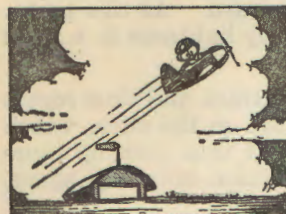
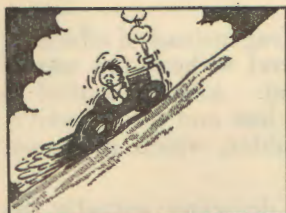
Practice smooth throttle coordination in climbs and glides.

BEFORE YOU TURN CHECK THE AIR ON ALL SIDES AND BELOW, PARTICULARLY THE AREA IN WHICH YOU WILL BE TURNING.



14. SERIES OF STALLS

Civil Aeronautics Bulletin No. 23; second edition. P. 158-165.



You need to learn about stalls for two reasons: First, every landing consists in approaching a stall while the airplane is just a little above the ground, and letting it "settle to the ground;" second, in a stall, an airplane is almost unmanageable and considerable altitude is lost before control is regained.

It is very dangerous to stall an airplane at low altitude (except, of course, while landing), since it is likely to hit the ground before you are able to regain control.

Therefore, it is very necessary that you practice stalls at a safe altitude, to be able to recognize when an airplane is approaching the stalling condition. You must learn to avoid allowing it actually to stall, except when you have sufficient altitude and stall it intentionally.

A STALL IS A PERFECTLY SAFE MANEUVER, BUT IT SHOULD NEVER BE ATTEMPTED AT ALTITUDES BELOW 2,000 FEET ABOVE THE GROUND.

An airplane stalls for one basic reason: The angle of attack has become too great for the speed at which it is moving through the air. However, since we have no "angle of attack" indicator, it is very important to know the conditions which lead to too great an angle of attack—and hence to a stall.

Most planes will continue to fly at airspeeds much below the normal cruising airspeed. In level flight most training planes stall at between 35 and 45 m. p. h. air speed. *However:* There is no such thing as a fixed stalling speed. The speed at which a plane stalls is a function of so many factors that one must not think of stalling speed but of *stalling condition*. Stalling speed is increased by the load and its distribution in the plane, by air temperature and pressure, by altitude, by steepness of bank, sharpness of a turn, whether power is off or on, ice on wings, etc., etc. **An airplane can be stalled in any position—even in a dive if one attempts to pull out of it too quickly.** Always it results from too much back pressure on the stick—and always **an approaching stall can be stopped by releasing the back pressure.**

Stalls will be demonstrated and you will execute them in order that you may (a) learn to recognize approaching stalls and (b) learn to recover (i. e., regain flying speed and control) with as little loss of altitude as possible.

An airplane may be stalled with power off or with power on. In a glide (when the power is off), the airspeed is maintained only by "coasting down hill".

Any attempt to make the glide too shallow, or to climb without sufficient power, results in a loss of airspeed and the airplane soon stalls. Loss of airspeed, whether power is on or off, results from raising the nose by the application of back pressure on the stick, or from flat skidding turns. There are other ways of losing airspeed, but they needn't be discussed here.

Symptoms of an Approaching Stall (Power Off):

Vision, which has played so large a part in your previous maneuvers, is of little help in sensing an approaching stall (except in noting the airspeed indicator). Rather, you have to learn to "feel" a stall. Though you won't be able to "see" a stall approaching, you may be able to "hear" it. Learn to sense a stall by the "sound" and the "feel" of your plane.

As the airspeed decreases, the first symptom of a stall is that the controls (both stick and rudder) begin to feel "loose" or "sloppy" (i. e., they move much more easily than at cruising speed). Also, you will discover that normal movements of the controls result in much less response on the part of the plane than in normal flight. As the stalling condition gets nearer and nearer, the controls become less and less effective.

First, you will notice that applying aileron pressure no longer enables you to bank or to pick up a low wing. As the stall approaches closer, you will discover that aileron pressures not only fail to secure the usual results, but that they actually result in the opposite effect on the plane.

This is due to the fact that, at slow speed, the aileron surfaces exert drag instead of affording lift. Hence, after aileron control is lost, **the wings are maintained level without the use of ailerons.** Your instructor will demonstrate how this is accomplished. Aileron control is lost first, but as the airspeed decreases, the elevators too will become less and less effective, until this control is lost also. The only remaining control is the rudder, which is almost ineffective.

Finally, in spite of all your efforts to hold the nose up, it will start dropping; actually the entire airplane is dropping through the air although it is still moving forward. At this point, you will literally "feel" yourself falling, as indicated by the feeling of bodily lightness (i. e., you won't be pressing down on the seat as hard as usual).

To recover from the stall, it is only necessary to lessen the angle of attack and thus regain flying speed. This is accomplished by simply releasing the back pressure on the stick, which drops the nose still lower and permits the plane to run "down hill" and thus pick up more speed. As cruising speed is regained, all controls will be found to function normally again, and the plane will maneuver as usual.

So far we have discussed "power off" stalls. An airplane may be similarly stalled with either cruising or full throttle engine R. P. M., but because of the power being applied, the nose will have to be held higher before the airspeed becomes low enough for the plane to "stall."

Similar loss of control will be experienced, but neither the rudder nor elevators will be as sloppy as in a "power off" stall, because of the "propeller wash" flowing over them during a "power on" stall. As the "power on" stall is approached you will note that the engine "labors." You will feel and hear this laboring, due to the greater vibration present.

To Summarize:

- (1) A stall is the condition of an airplane when it is no longer flying but is, rather, falling through the air.
- (2) It is an extremely dangerous condition unless: (a) the plane is within a few feet of the ground and in position for a landing, or (b) the plane is a couple of thousand feet above the ground so that it can be dived to regain flying speed.
- (3) You must learn to "feel" an approaching stall through the controls and "in your seat."
- (4) Recovery is always accomplished by easing off back pressure and attaining flying speed.
- (5) Keep an eye on the airspeed indicator and don't let it approach stalling speed unless you are practicing stalls at sufficient altitude.

As noted on the previous page, stalls may be executed with "power on" or with "power off." Furthermore, we distinguish three types of stalls under each of the two conditions. No. 1 is a "partial stall," No. 2 a "normal stall," and No. 3 a "complete stall."

Specific instructions for executing this series of six stalls are as follows: Note carefully the difference in procedure involved so that you will be able to go through the entire series without any coaching from your instructor or the "check-flight" pilot.

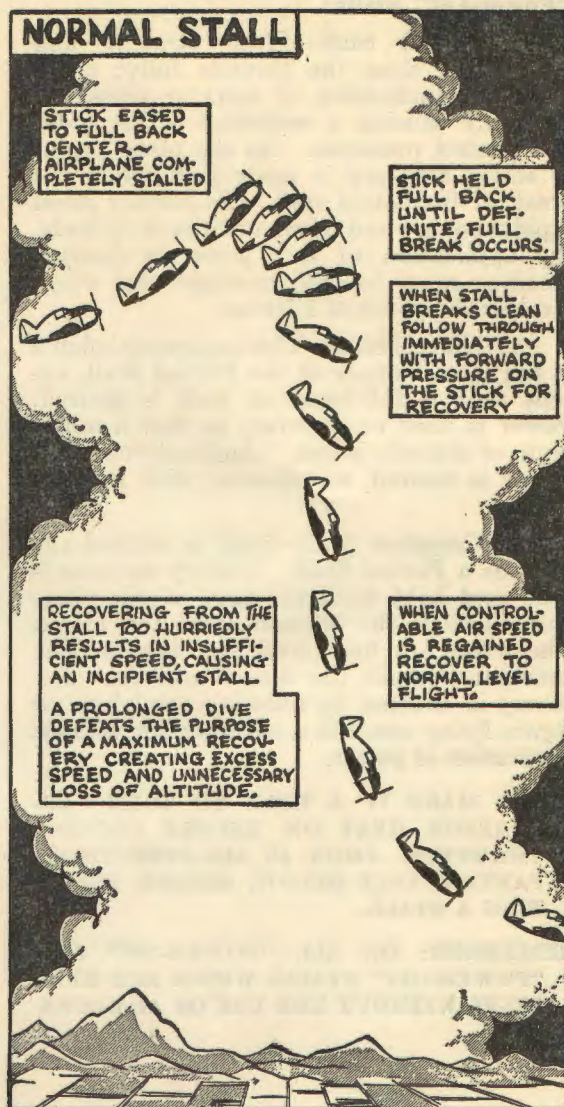
"Power On" Stalls:

1. **Partial Stall**—Set throttle at cruising engine R. P. M. in level flight. Slowly and steadily maneuver the airplane by the use of elevator pressures into an attitude of excessive climb causing a constantly decreasing airspeed and resultant loss of control pressure. As the plane begins to settle, but just before the "break"¹ occurs, full throttle is applied and recovery is effected by application of forward stick in dropping the nose to the horizon.

2. **Normal Stall**—Start as above but apply back pressure on stick until a definite break occurs. Emphasis should be placed on the importance of getting a clean-breaking stall. Recovery is effected by using full power **just after** the break and consists of a moderate dive until flying speed is recovered.

3. **Complete Stall**—Stall is started as above but stick and elevator action continued until maximum elevator action is obtained. Heading is held constant and wings level, stick full back, until the nose falls through the horizon on the downward swing. Recovery is effected by application of full power as the nose passes through the horizon on the way down and a moderate dive is made until flying speed is regained. **Wings will be held level without the use of ailerons.**

¹ When the air speed further diminishes and nears the stalling speed the nose will no longer stay in its original position. Instead it drops. This is called the "break" of the stall.

SERIES OF STALLS

SERIES OF STALLS

"Power-Off" Stalls:

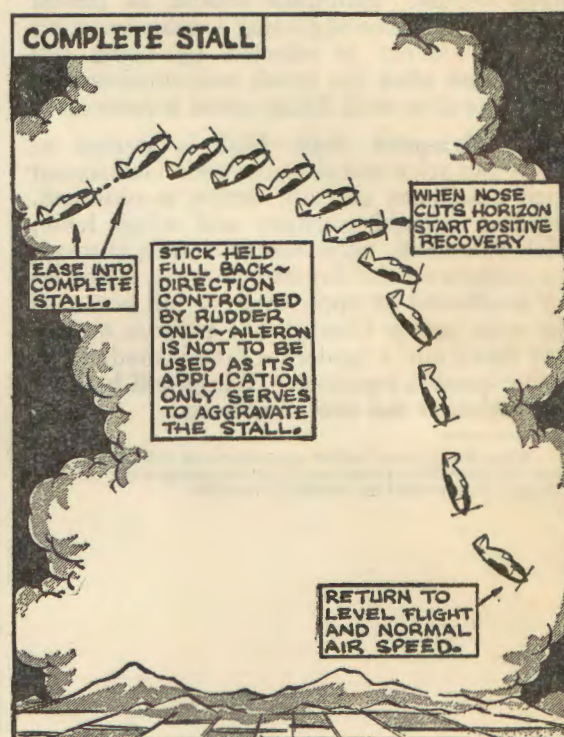
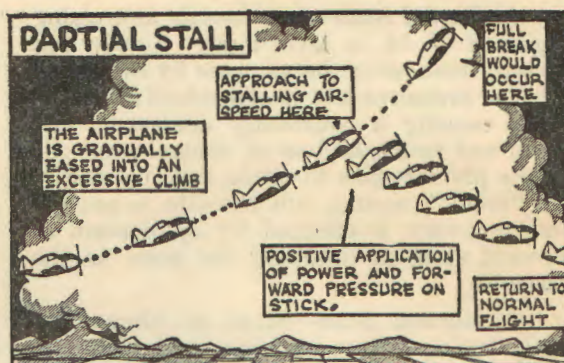
1. **Partial Stall**—From straight and level flight close the throttle fully; climb plane by application of elevator pressures, gradually causing a reduction of air speed and control pressures. As the plane begins to settle, recovery is made just before the break of the actual stall. To further effect rapid recovery and minimum loss of altitude, the application of full power is desired. Heading must be held constant and wings level, without use of ailerons.

2. **Normal Stall**—This maneuver is flown in the same manner as the Partial Stall, except that a full-breaking stall is desired. Power is used on recovery so that a minimum of altitude is lost. Application of full power is desired, coordinated with forward stick.

3. **Complete Stall**—Stall is started the same as a Partial Stall. Full-up elevator is used and held until the nose of the plane cuts through the horizon after the break. The wings are held level and the heading constant without the use of ailerons. Recovery is effected by allowing the plane to regain flying speed in a normal glide without application of power.

NOTE: MAKE IT A RULE TO TURN CARBURETOR HEAT ON BEFORE CLOSING THROTTLE. LOOK IN ALL DIRECTIONS, PARTICULARLY BELOW, BEFORE EXECUTING A STALL.

REMEMBER: ON ALL "POWER-ON" AND "POWER-OFF" STALLS WINGS ARE HELD LEVEL WITHOUT THE USE OF AILERONS.



15. RECTANGULAR COURSE

Civil Aeronautics Bulletin No. 23; second edition. P. 157-158.

Flying a rectangular course consists of following a ground pattern which is in the shape of a large rectangle. You'll realize why it's valuable to practice this maneuver when you remember that the flight path or traffic pattern around an airport is in the shape of a rectangle.

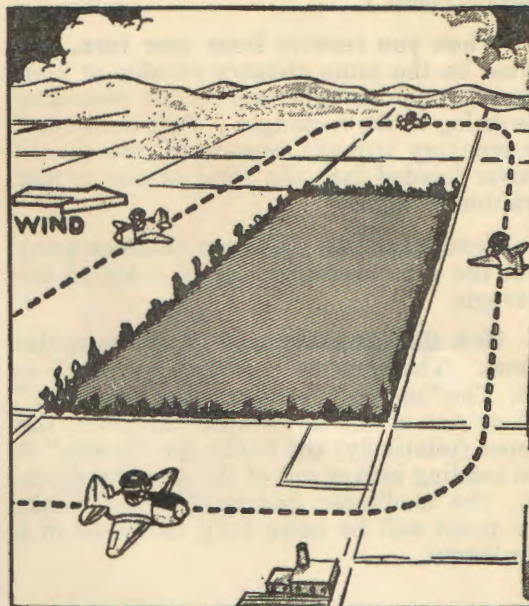
The sides of the course should consist of easily identifiable straight lines on the ground, and should not be less than one-fourth mile, or more than one mile in length. Roads, fences, ditches, tracks, and edges of fields make good courses. Be sure that the course you choose is well away from all regular air traffic. Your altitude should be 500 feet. The maneuver is done at cruising speed.

The plane should be flown far enough outside of the course that the course is easily visible at all times.

Your ground path should be parallel to the sides of the course at all times. Therefore, when flying cross-wind you must turn the plane slightly into the wind to correct for drift. This is called "crabbing" since your plane will apparently be moving somewhat sideways over the ground, although its flight path will be parallel to the sides of the course, and it will be flying straight through the air.

It is not necessary to hold rudder when crabbing. After you turn the plane the necessary amount into the wind, by coordinating the stick and rudder, neutralize the controls just as you always do when flying straight and level through the air, although the air mass (wind) may be moving across the course you are following on the ground. When you row a boat straight across a river, you have to head upstream in order to counteract the current. The principle is the same in "crabbing."

The turns are not made until you reach the corners of your course. Then, the corners of the course should be the center of your turn.

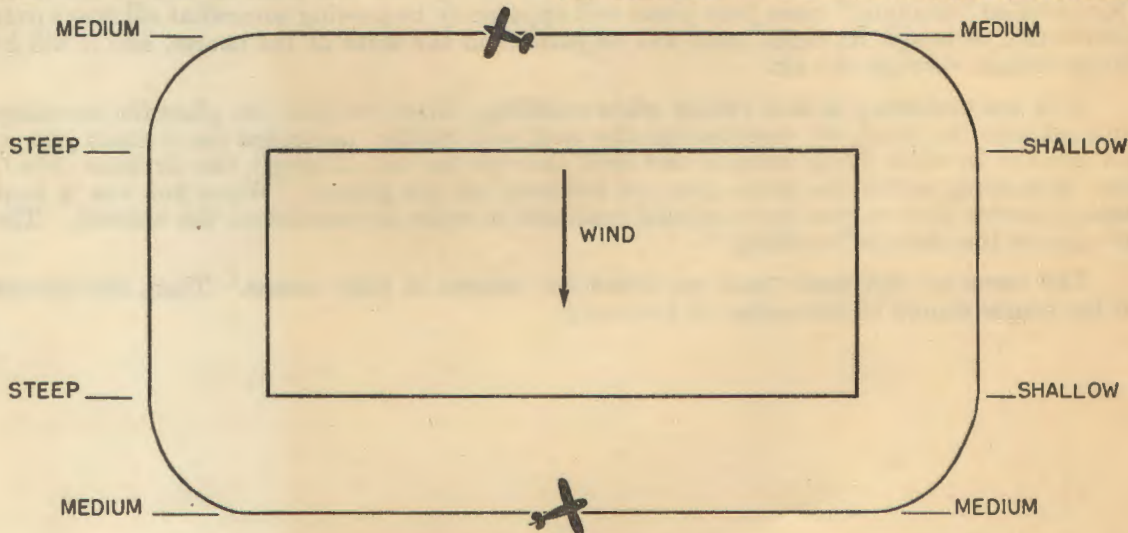
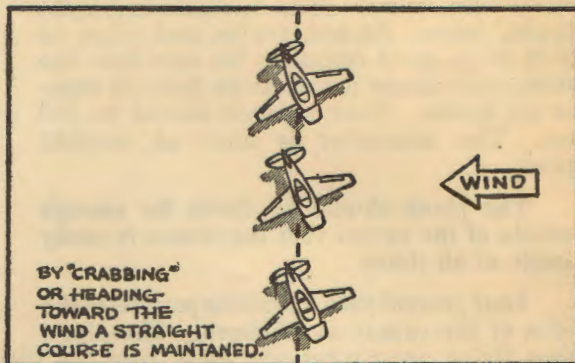
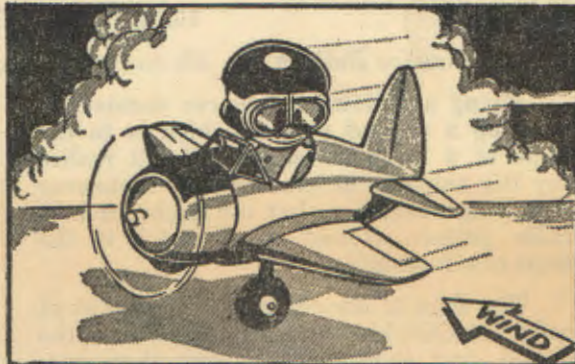


Keep the radius of the turn constant. This means that in a wind, you will have to vary the amount of bank as you turn. (See diagram below.)

When you recover from your turn, you should be the same distance outside of your ground course as you were on the preceding side or leg of the rectangle. Furthermore, if the recovery is made cross-wind, you should recover headed into the wind at the proper "crabbing" angle.

Remember, fly the same distance away from the ground course on all sides of the rectangle.

How the bank is varied in a rectangular course. The general principle involved is this: The "nearer" the plane is to "heading" into or out of the down-wind direction, the steeper (relatively) the bank; the "nearer" it is to heading into or out of the up-wind direction, the shallower (relatively) the bank. This point will be more fully discussed in a later lesson.



16. TAKE-OFFS

Civil Aeronautics Bulletin No. 23; second edition. P. 165-168.

First, check the wind direction.

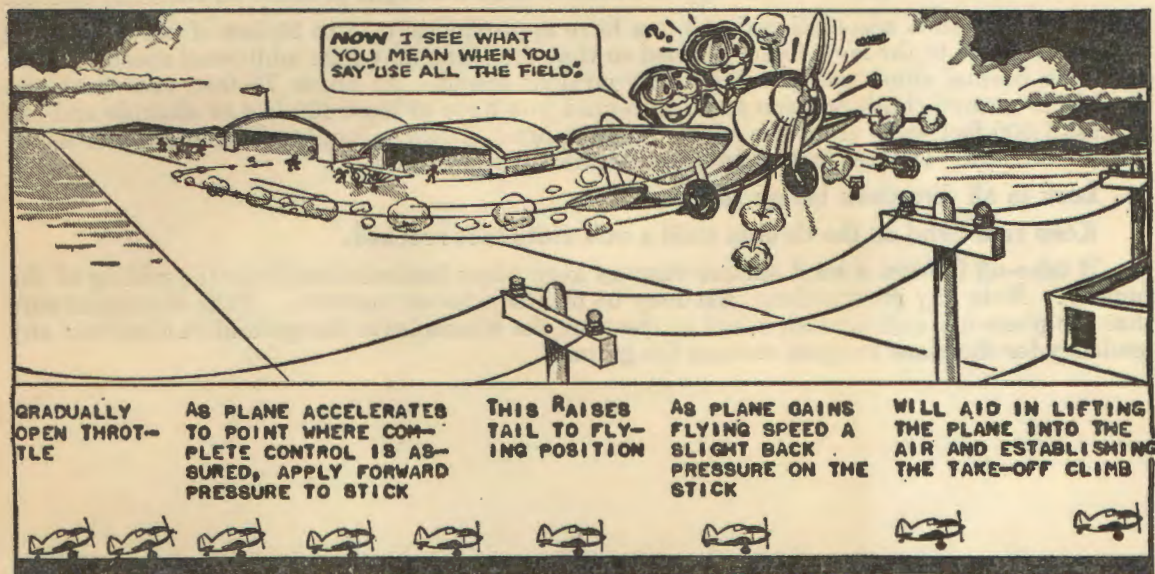
Take-offs should always be made into the wind. Lift depends on air speed. The length of your take-off run depends upon how quickly you can gain sufficient air speed to take off. Therefore, take advantage of the wind.

Have the full field before you when you start to take off. Remember that you can't use what you leave behind.

Make a complete turn to the right after reaching the take-off area, in order to check incoming traffic, presence of other planes and ground obstructions. If other planes are landing, turn and face them until all is clear. (If traffic circles to the *right* around your airport, you should turn *left* before taking off.)

When the plane is headed into the wind ready for the take-off, be sure to check the following, **and then take off immediately:**

1. Instrument panel (all instruments).
2. Fuel shut-off valve . . . to see that it is in the FULL ON position.
3. Ignition switch . . . to see that BOTH magnetos are ON.
4. The stabilizer setting . . . to see that it is correct for take-off.
5. The runway ahead . . . to see that it is clear of other planes or obstructions.

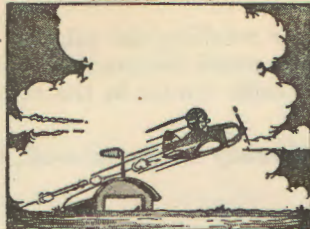




TAKE-OFF CLIMB



NORMAL CLIMB



Then: With the stick slightly back, open the throttle gently until the plane begins to move. Then gradually open the throttle to its **fullest extent**. (After experience has been acquired, these first two steps will merge into one.) After the throttle is wide open, ease the stick ahead until the plane assumes a position that is the same as a shallow climb position.

After this it will be necessary to hold slight back-pressure to keep the plane in this position. Maintain this position until the plane takes itself off. Use particular caution to keep a straight path on the ground, using only the rudder. It's a good idea to pick some object at the far end of the field to aim at.

Bear in mind that the plane may begin swinging toward the left. (Due to the fact that the propeller rotates clockwise as seen from the pilot's seat, the plane tends to rotate counter-clockwise, due to torque and propeller slipstream. This is known as **torque effect**.) To correct for this tendency to change direction, you will have to hold a slight pressure on the right rudder.

After take-off is accomplished and you have approximately 15 to 20 feet of altitude, lower the nose slightly to the level flight position so that the plane may gain additional speed. Then assume a normal climb and proceed to fly straight ahead. At about 75 feet, ease back the throttle to normal climb position and climb until you have at least 400 feet of altitude and are at least 1,000 feet away from the edge of the airport. At this time, level off and make a 90° turn to the left. (Follow local field rules, if different from these.)

Look in all directions before turning.

Keep your hand on the throttle until a safe altitude is reached.

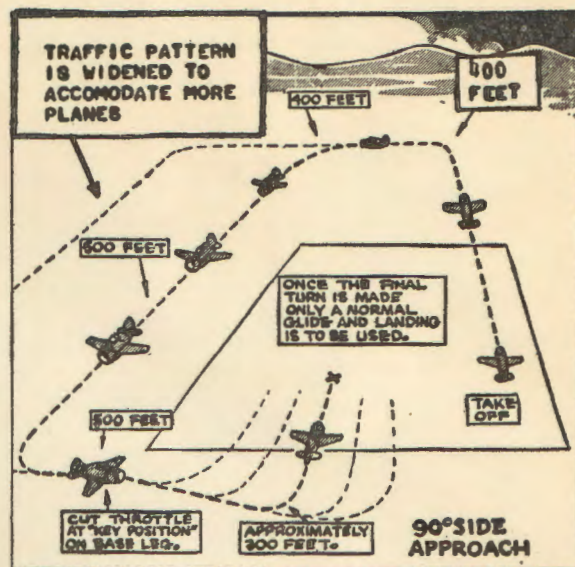
If take-off is from a hard surface runway keep plane headed directly in the middle of the runway. Note any obstructions that may be on the sides of runways. Take particular care that the plane has sufficient air speed at the time the wheels leave the ground to eliminate any tendency for the plane to again contact the ground.

17. 90-DEGREE APPROACH

Civil Aeronautics Bulletin No. 23; second edition. P. 178-180.

The approach to a landing that you will use most often is the "90-degree approach." Unless local conditions and regulations specify otherwise, all traffic around an airport is to the left, i. e., one approaches the airport with it on the left side and makes left turns in circling it. A 90-degree approach is begun by flying cross-wind, on the down-wind side of the airport, at an altitude of 500 feet. While still flying cross-wind, you close the throttle and begin a glide. Then you make a gliding turn into the wind and come in for a normal landing, usually just beyond a chosen point or "spot" on the field.

The 90-degree approach to a landing is used in preference to a straight glide, since in a long, straight glide it is difficult to estimate your height, and the length of your glide (which may be affected by wind conditions). Also your visibility into the area directly ahead of you is poor. The most important advantage of this type of approach is that it enables you to correct for errors in judgment regarding wind conditions, and the distance the plane will glide.



While you are flying cross-wind on the down-wind side of the airport, close the throttle and begin your normal glide. Your position at the beginning of your glide is your **KEY POSITION**. This is the point at which you estimate your height and distance from the field, and the probable length of your plane's glide. The 90-degree turn into the field can be made anywhere along this cross-wind leg of your approach, but never at an altitude of less than 150 feet.

Turn to the left into the field from the cross-wind leg at the point from which you can maintain a normal glide and land at the chosen or designated spot. Therefore, at your key position, if you decide that you are too high (or too close to the field), continue your cross-wind glide longer before making the turn into the field. Or, if you decide that you are too low (or too far from the field), you can make the turn into the field sooner. If you feel that you still won't have enough altitude to clear the edge of the field safely, open your throttle to cruising position for a while to maintain a safe altitude in the approach.

You can estimate the velocity of the wind by how much your plane drifts while flying cross-wind. On the cross-wind leg, you should crab enough to keep your flight path at right angles to the wind.

Try to maintain a normal glide throughout this maneuver. The point at which you land depends upon where you close the throttle and where you turn into the field.

Keep in mind constantly your position in the air in relation to the spot at which you want to land.

Keep your nose down in the gliding turns. Turn carburetor heat "on" before closing throttle. Clear the engine about every 20 seconds during the glide.

Look in all directions for other planes and obstructions in the air and on the ground.

Remember: "A 'STIFF' NECK IS BETTER THAN A 'BROKEN' NECK."

18. LANDINGS

Civil Aeronautics Bulletin No. 23; second edition. P. 169-175.

The basic principle involved in landing an airplane with power off is to bring it close to the ground and then keep it in the air as long as possible. Sit in the plane while it is on the ground, and note the position of the nose with respect to the horizon. This is the position the plane should be in at the instant before it touches the ground in landing.

To make a landing, first assume a normal glide. Continue this normal glide until you are approximately 15 or 20 feet above the ground. Look ahead and to the sides of the plane to judge your altitude; never look straight down. When you are about 20 feet above the ground, start the leveling-off process. This is called "breaking the glide". Gradually raise the nose as the plane settles so that by the time you are about 5 feet above the ground the plane will be in level flight position.

From here on try to keep the plane in the air. To do this, it will be necessary to keep raising the nose progressively farther as the plane loses speed and begins to settle. By the time the plane touches the ground the stick should have been eased all the way back, and the plane should be in the "three-point" position. Throughout the landing process, be sure the wings are level and the plane keeps in a straight path.



The landing is not complete until the plane stops rolling. Therefore, be very careful to keep the stick fully back and the plane rolling in a straight path on the ground, into the wind.

Vision is the most important sense used in landing. Keep your eyes level and look far enough ahead so as to keep objects from blurring.

Cautions:

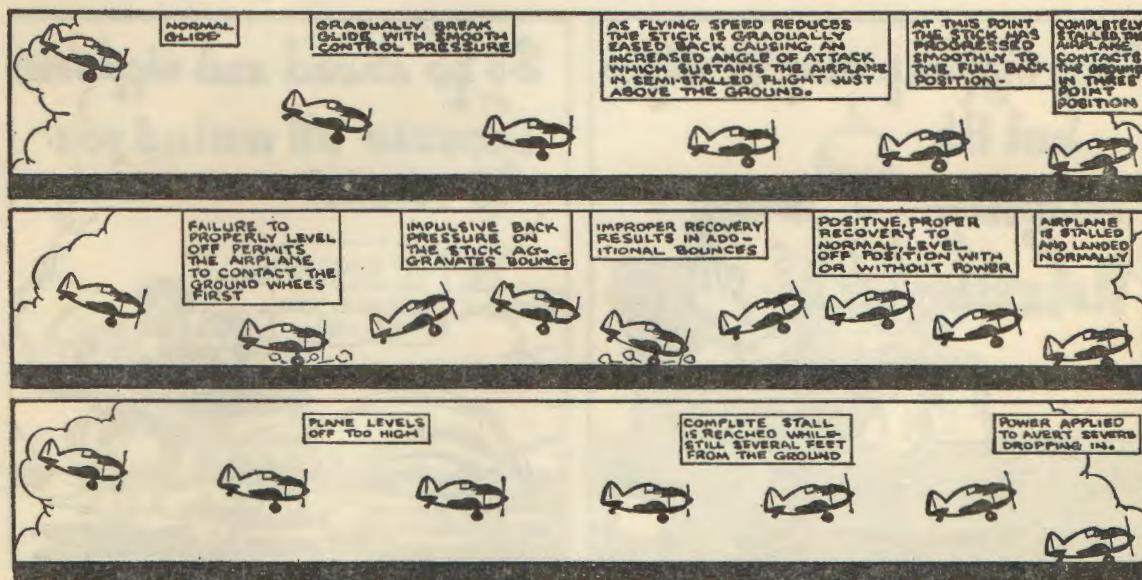
If you notice something in your path as you are landing, open the throttle, attain proper altitude and circle the field again.

If you make a bad bounce in landing, open the throttle at once, with a smooth motion, attain proper altitude, and circle the field again. (Your instructor will enlarge on this aspect of landing.)

Helpful Rules For Landing:

1. Keep one hand on the throttle at all times.
2. Keep the airplane headed directly into the wind.
3. Maintain a normal glide at all times; altitude cannot effectively be lost or dissipated by diving, nor can a normal glide be "STRETCHED".
4. Don't "stare" at the nose of the plane, don't look straight down to judge your altitude.
5. Be on the "look-out" for other aircraft, field hazards, obstructions, etc.
6. Get the tail down just before the wheels touch.
7. **Never** push the stick forward to correct for an error, either use the throttle or ease off the pressure.
8. When in doubt, open the throttle and go around again.
9. After the landing, keep the stick back as far as possible as firmly as possible, until the plane stops rolling. Remember that a landing is not completed until the plane stops rolling.
10. Do not become "tense" or "stiff" on the controls.

Remember: THE PLANE WILL NOT LAND "THREE POINT" UNLESS IT IS IN A COMPLETE STALL CONDITION AT THE INSTANT THE WHEELS CONTACT THE GROUND.



19. "S"-TURNS ACROSS A ROAD

Civil Aeronautics Bulletin No. 23; second edition. P. 181-183.

S-turns across a road consist of a series of 180-degree turns made across a road or some straight line on the ground, such as a fence, or tracks. Whatever landmark is used should be 90 degrees to the direction of the wind and far enough away from the regular air traffic so as not to interfere with it.

This is a basic maneuver designed to teach you subconscious control coordination, how to fly a balanced pattern over a given terrain and how to recognize and overcome the effects of wind drift while flying a pattern upwind and downwind.

It further helps you to divide attention inside and outside the plane while mastering the art of flying.

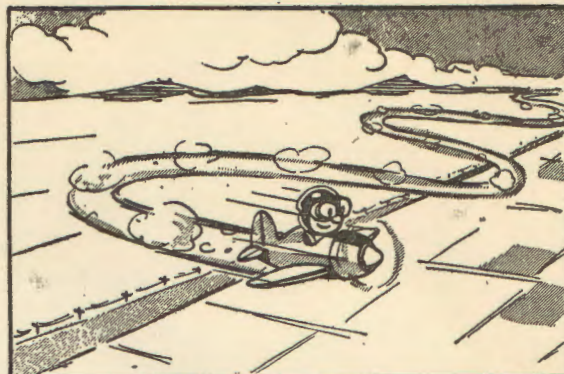
The maneuver is done at 500 feet and at cruising air speed.

The maneuver is started by flying straight and level across the road and at an angle of 90° to it. A turn of 180 degrees is started immediately after crossing the road.

The bank is varied in such a way that the path of the plane over the ground is a half circle so that you cross the road flying straight and level when the turn is completed.

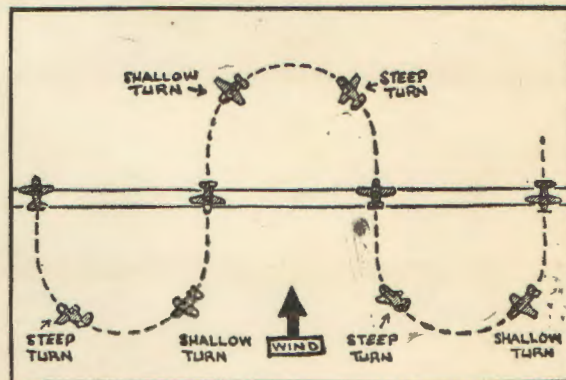
Immediately after crossing the road, a turn in the other direction is started. Again the plane's path over the ground is a half circle.

This half circle should be the same size as the preceding one.



"S" Turn Across a Road

This maneuver has its very proper place in Primary Training, laying the foundation for accurately and safely piloting an aircraft while dividing attention between the aircraft and outside objects. The ground pattern is the desired objective and is obtained through the necessary allowance for effect of wind drift.



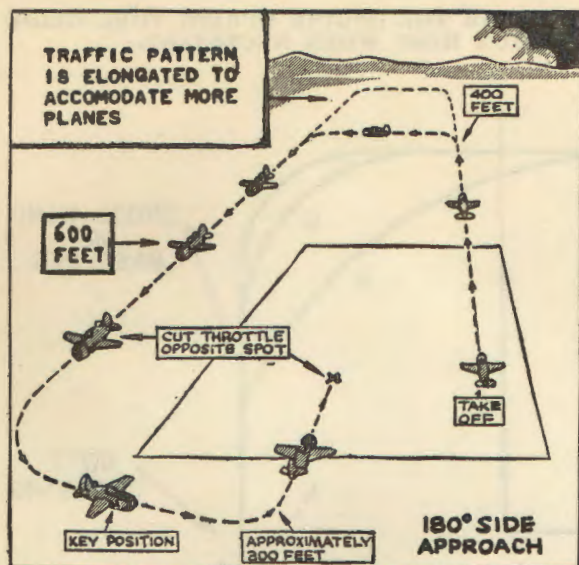
Start the upwind turns shallow, but steepen them when sufficient ground distance has been covered to permit completing the 180-degree turn. The shallow turn, requiring a larger radius in the 180-degree turn, will lengthen the ground pattern and "make distance" into the wind.

Start the downwind turns steeply, decreasing the angle of bank to a shallow turn when sufficient ground distance has been covered to permit completing the 180-degree turn. The steep turn permits a smaller turning radius, thus allowing control of the rate of drift.

Remember: The nearer the plane is to heading into or out of the down-wind direction, the steeper (relatively) the bank; the nearer it is to heading into or out of the upwind direction, the shallower (relatively) the bank.

20. 180-DEGREE SIDE APPROACH

Civil Aeronautics Bulletin No. 23; second edition. P. 190.



The 180-degree precision landing is a landing made on a designated spot, following an approach which describes half of a rectangle.

The maneuver is begun (that is, the throttle should be closed) when the plane is directly opposite, and to the side of, the spot.

The plane is glided down-wind, and a turn of 90 degrees is made so that it is flying directly cross-wind. Then another turn of 90 degrees is made (that is, you turn into the field) and the plane is glided in to a normal landing.

This is a particularly valuable maneuver, since it is the approach often used in forced landings.

Your flight path, or pattern over the ground depends on your altitude and on wind conditions.

The higher you are the farther you will glide.

The stronger the wind, the shorter your path over the ground will be when headed into the wind, and longer when headed down-wind.

Since you will be making these approaches from a relatively constant altitude of approximately 600 feet, the important factor is the wind. Your problem therefore is to adjust the length of the "legs" of your approach so that your glide will be ended and the landing made just beyond the designated spot.

The down-wind leg: If the wind is weak, this leg should be longer; thus your cross-wind leg will be flown farther from the spot. If the wind is strong, your down-wind leg should be shorter, and your cross-wind leg will be flown closer to the field.

The cross-wind leg: At the beginning of this leg is your "KEY POSITION." From this position you estimate how far the plane will glide, and then decide what you must do to land at the intended spot. If, because of your height and distance from the field, you think your glide will be too short to hit the spot, you can make your turn into the field sooner (at position A; see diagram on following page).

If you think your glide will be too long (that is, if you have a lot of altitude to lose) glide farther on your cross-wind leg (position C, see diagram) before turning into the field. While flying cross-wind, it will be necessary to "crab" in order to stay the same distance down-wind from the spot.

The final approach: After the turn into the field is made, concentrate primarily upon making the landing. Since a normal glide must be maintained, the question of whether or not you hit the spot has already been decided by the nature of your flight path on the first two legs.

Remember:

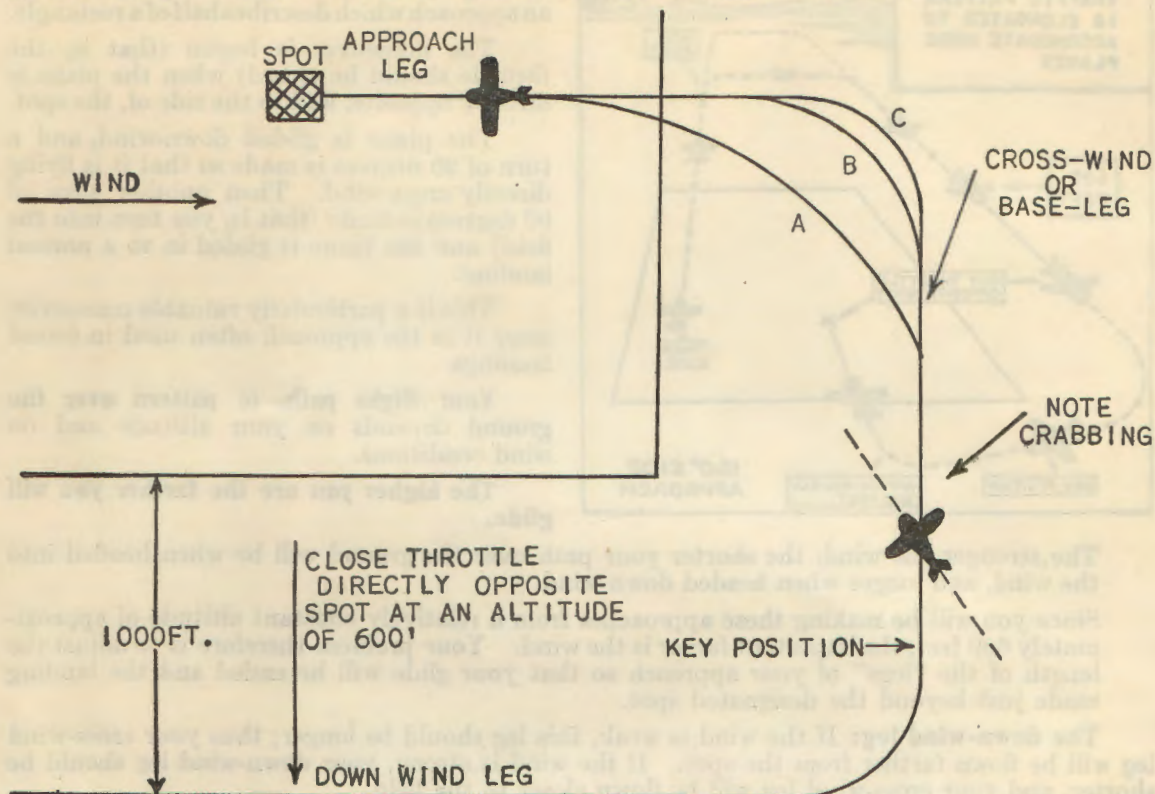
The precision of your landing depends on the first two legs, which should be approximately equal in length.

Keep a sharp lookout ahead and below for other planes.

Keep in mind constantly your position in the air in relation to the spot at which you want to land. This is the only way in which you can judge the length of glide necessary, and the point at which you turn into the field.

Don't select a definite spot or object on the ground as your key position. Rather, the key position is a specific point in your flight path. After all, you may want to use the 180° approach on a strange field some day.

KEEP YOUR NOSE DOWN IN GLIDING TURNS. CLEAR THE ENGINE DURING YOUR GLIDE ABOUT EVERY TWENTY SECONDS. USE CARBURETOR HEAT WHEN NECESSARY.



21. 180-DEGREE OVERHEAD APPROACH

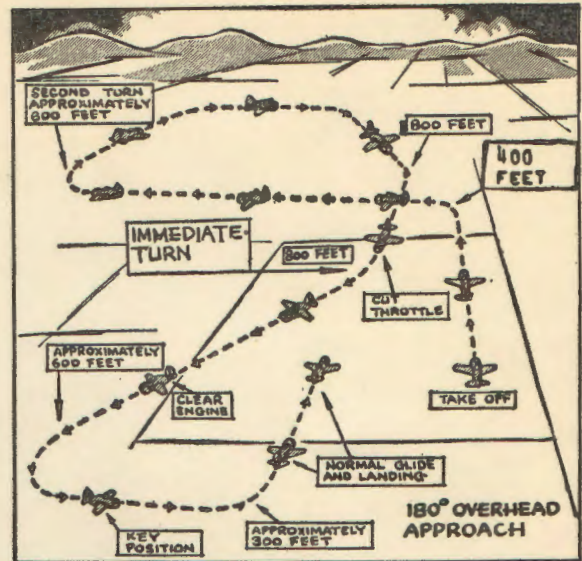
The 180-degree overhead approach is a maneuver in which the plane is flown to the key position for a precision landing at a designated spot on an auxiliary field.

This maneuver is particularly valuable in case of a forced landing while flying down wind when directly over the place of intended landing.

The maneuver is begun by closing the throttle while flying down wind, directly over the spot on the auxiliary field.

The altitude over the spot should be approximately 800 feet.

Immediately after closing the throttle a 45-degree right turn is made and the plane glided to a point at the side of the field where a 180-degree side approach to the field can be made.



Like the 180-degree side approach, the wind is an important factor, and you must allow for drift and wind velocity on all legs of the approach.

The main object is to maneuver the plane to the key position where a normal 90-degree side approach to the spot can be accurately executed.

The altitude over the spot will determine the distance of your glide to reach the key position.

Constantly keep in mind your position in the air in relation to the spot at which you plan to land.

Always maintain a safe gliding speed particularly in your gliding turns.

Remember to clear engine about every 20 seconds in the glide.

As this maneuver does not conform to the regular flow of traffic at an airport it must always be practiced at an auxiliary field where there is absolutely no other traffic.

22. SERIES OF EIGHTS (ELEMENTARY, NO. 1 AND NO. 2)

If your plane left a record of the path it flies in the air, that path would usually not be exactly the same as the ground path of the plane. If there is any wind, the whole air mass is moving over the ground. Since the air path of the plane is a part of the air mass which is moving over the ground, a plane whose path in the air was a perfect circle would never have a ground path of a perfect circle except in cases where there was no wind at all.

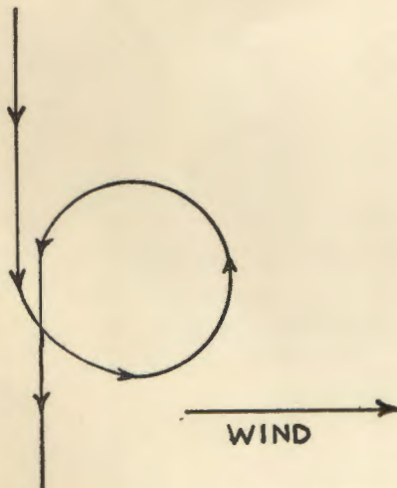
The movement of a plane with the air mass is called "drift". The purpose of the elementary eights is to show you the effect of drift on your ground path during a turn, and to give you practice in compensating for this drift in order to fly a given path over the ground.

Elementary Eights No. 1 (The Half Eight).

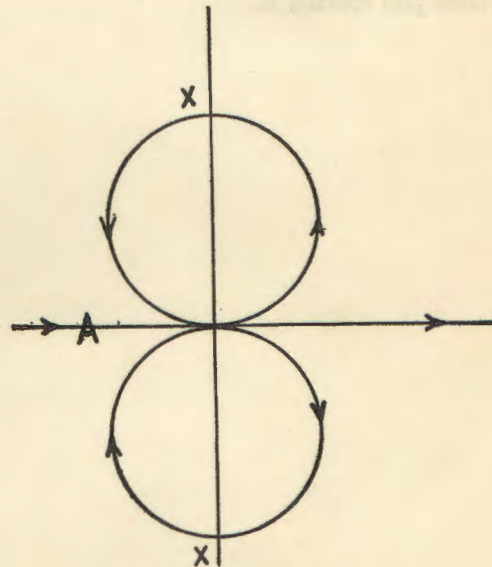
The purpose of the half eight is to show you the effect of "drift" on your ground path during a turn.

Select a road or similar landmark which lies cross wind and fly your plane at 500 feet directly down it. (You will have to "crab" a little so as to not "drift" away from the road.) (See diagram below.) Then make a 360° degree turn in either direction. Be particularly careful to maintain a **constant degree of bank** throughout the turn.

You will find that the turn will be completed with the plane flying some distance from your landmark and on the down wind side of it, provided, of course, that there is appreciable wind. This maneuver illustrates the amount of drift you can expect in winds of given velocities. In the maneuvers included in the rest of the series of eights you will be required to maneuver your plane to compensate for this drift in order to follow a prescribed ground pattern.



NO. 1 HALF EIGHT
(CONSTANT BANK)



NO. 2 ELEMENTARY
EIGHT

Elementary Eights No. 2.

In this maneuver, which is done at 500 feet, you will make two 360-degree turns on either side of the intersection of two landmarks, such as two roads, or fence rows. The general pattern of the maneuver is as follows: Fly down wind above the landmark which lies with the wind (Landmark A in the diagram shown). When you reach the intersection, start a turn in either direction. The turn should be completed directly above the intersection, with the plane flying straight and level, and another 360-degree turn made immediately in the opposite direction. This turn should also be completed when the plane is directly over the intersection.

When you complete your turns, the plane should be flying straight and level directly over the intersection of your landmarks. This means that your *ground path* should be a perfect circle, and that you will therefore have to compensate for drift.

Drift during a turn is compensated for by varying the bank of the plane. When you are heading up wind, and turning, because of the drift you have to actually fly farther "through the air" than if you were flying down wind. Therefore you make your turn more gradual, which means that you decrease your bank.

When you are heading down wind, and turning, since the drift is carrying you over the ground, you actually don't fly so far "through the air". Therefore, you make your turn sharply, which means that you increase your bank.

Remember the following general principles:

The "nearer" the plane is to heading into, or out of, the down wind direction, the steeper (relatively) the bank.

The "nearer" the plane is to heading into, or out of, the up wind direction, the shallower (relatively) the bank.

Varying the bank to correct for drift when turning is a gradual and continuous operation. Handle the controls gently, and make the transition from one degree of bank to another smooth, and almost imperceptible.

The emphasis in these maneuvers is on precision. Always keep in mind your plane's position in relation to the landmarks. Keep your altitude constant. If you lose altitude on one of the turns try to regain it on the next one. You should complete the maneuver at the same altitude you started it.



Elementary Eight No. 2

In the maneuver which is shown in this diagram, you will make two 180-degree turns in opposite directions. The first turn is made at the top of the circle, and the second turn is made at the bottom of the circle. The path of the plane is a figure-eight shape. When you make the first turn, you are heading into the wind. When you make the second turn, you are heading down the wind. The text 'NO. 2 ELEMENTARY EIGHT' is written below the diagram.

23. FORCED LANDINGS ON TAKE-OFF

Civil Aeronautics Bulletin No. 23; second edition. P. 192-195.

If the engine quits on take-off, and you have less than 100 feet of altitude: Don't look back—, **DON'T TURN BACK—**, but—

(1) Establish a normal glide immediately.

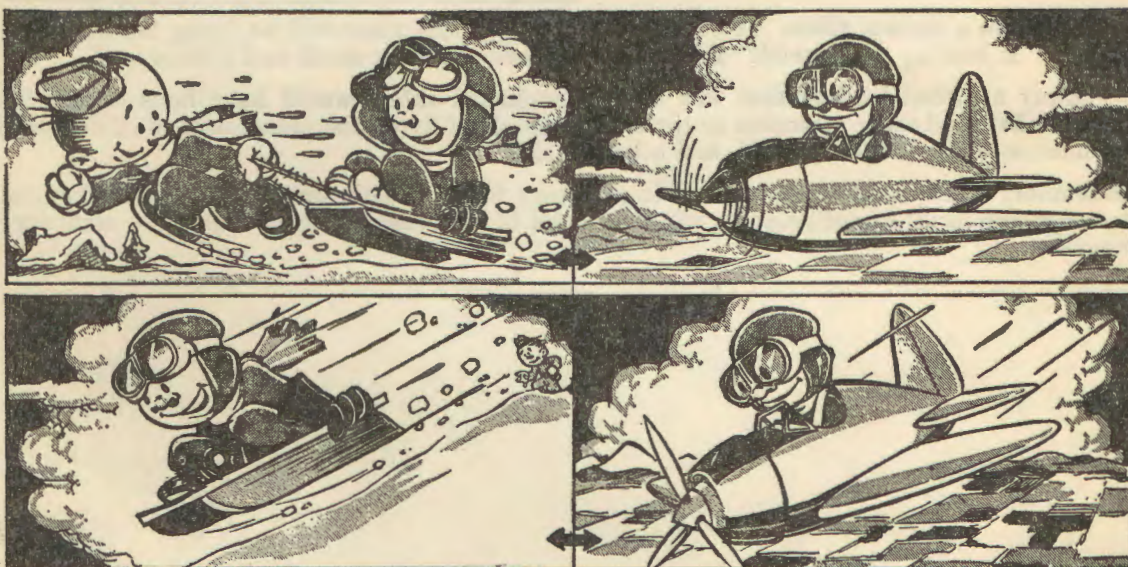
(2) Make a normal landing straight ahead, regardless of what lies ahead.

NEVER ATTEMPT TO TURN BACK INTO THE FIELD! MANY HAVE TRIED IT BUT FEW HAVE SUCCEEDED!

Forced landings on take-off are potentially dangerous but need not be. The main danger lies in trying to turn back into the field.

If you try to turn back: (1) You are attempting a turn at very low altitude and low air speed, which is inviting a stall, and (2) Even if you do succeed in making the turn, you will be landing down wind.

TO REPEAT: IF YOUR ENGINE QUITS ON TAKE-OFF, FIRST GET THE NOSE DOWN; ESTABLISH A NORMAL GLIDE; THEN MAKE A NORMAL LANDING, STRAIGHT AHEAD, AND REMAIN RELAXED.



24. 90-DEGREE FORCED LANDINGS

If the engine quits when you have more than 100 feet but less than 500 feet of altitude: **First establish a normal glide.** Then pick out a field into which you can land (preferably into the wind). Plan your approach to the field, using either a 180° or 90° approach, depending upon your position, altitude, and distance from the field.

If there is no suitable field within gliding distance, and there is nothing below but trees, rocks, water, etc., land into the wind, for it is then that you have your slowest ground speed.

Things to Remember About Forced Landings:

1. Always try to have a reasonably safe field within gliding range.
2. Do not change your mind after selecting a field (unless your distance and altitude permits).
3. A normal glide cannot be "STRETCHED."
4. Plan your approach to the field taking particular care as to wind direction and velocity.
5. Be calm and relaxed-----a forced landing is, after all, only another landing.
6. It is impossible to dive down to a field and land on it.
7. Maintain a safe gliding speed. Avoid excessive air speed.
8. There is only one hard and fast rule for forced landings-----they must be accomplished safely.

Remember: The increased angle of glide necessary for a safe air speed, the change in control pressures caused by loss of propeller slipstream, and the increased "drag" caused by a stationary propeller.

25. 180-DEGREE FORCED LANDINGS

Civil Aeronautics Bulletin No. 23; second edition. P. 192-194.

Think of altitude as space for maneuvering. The greater the altitude, the greater the distance you can glide, if necessary, to a safe landing area.

If the engine quits when you are above 500 feet:

First establish a normal glide.

Then pick out a field in which to land.

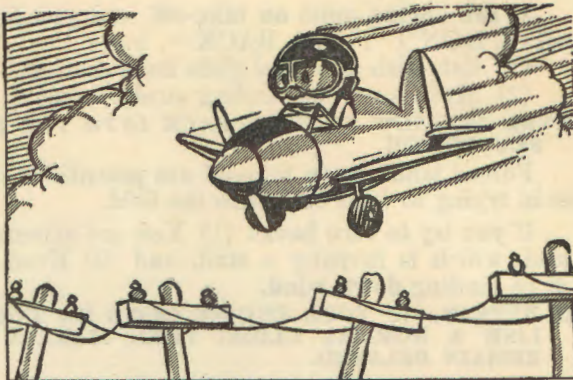
Plan your approach, so that you can land on the field into the wind.

Remain relaxed.

Maintain a normal glide. If you glide too steeply, the plane will be flying too fast for a landing. If you try to "stretch" the glide, the plane will only mush and it may stall.

Many a forced landing that was not accomplished safely would have been successful had the pilot paid more attention to the fundamentals of flying the plane, instead of devoting too much attention to the ground, and other details.

Remember: The increased angle of glide necessary for a safe air speed, the change in control pressures caused by *loss of propeller slipstream* and the *increased drag* caused by a *stationary propeller*.



26. NORMAL SPINS

Civil Aeronautics Bulletin No. 23; second edition. P. 197-201.

It is always surprising, nowadays, to realize how many trainees have an aversion to spins. In the early days of flying, this was justified. Planes weren't the well-designed, well-balanced precision machines that they are today. The present-day plane can be easily controlled in a spin. It is a lot easier to get out of a spin than it is to get into one. Today's plane is so designed that it must be made to spin.

A spin is extremely dangerous, if it occurs close to the ground. But when there is plenty of distance between you and the ground (spins are executed at an altitude of over 3,000 feet), and you know the simple rules of recovery, there is nothing to worry about. A spin is one of the most easily executed flight maneuvers. It places no excessive load on the plane when properly performed; the same is true of any other normal maneuver.

Occasionally, some people get a little sick in a spin. That doesn't prove that spins are either dangerous or uncomfortable. Some people also get sick just from riding in trains or cars.

Because an airplane is a heavier-than-air machine, it flies only when the air flowing over the wings creates lift sufficient to overcome the forces of gravity. Speed, therefore, is essential to flight.

As flying speed is lost or reduced below a certain minimum, commonly called "stalling speed" a stall will occur.

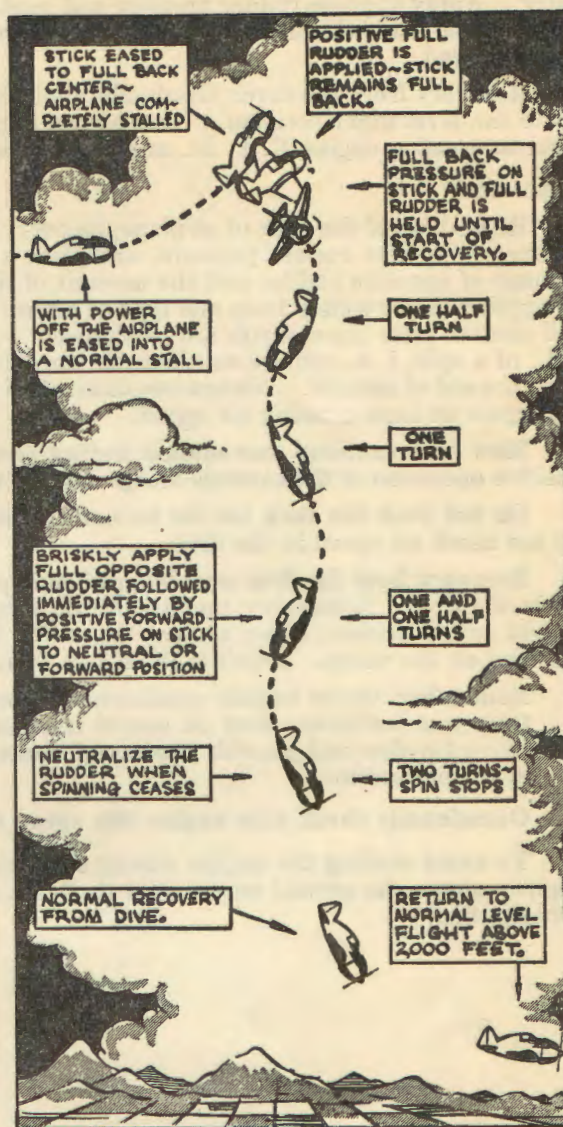
A spin results from a severe stall, which has been developed either intentionally or accidentally. Similarly, a severe stall will usually result in a spin.

The proper method of entry to, and recovery from, spins will be reviewed on the ground, prior to the flight.

Spins should be started at an altitude of at least 3,000 feet, but not more than 3,500 feet. This maximum altitude is due to present Civil Air Regulations.

After proper altitude is reached, first check traffic by looking below and around. Then turn on the carburetor heat and close the throttle² and raise the nose of the plane to approximately landing position. Hold the plane in this attitude by increasing the back pressure, being sure to keep the wings level with the rudder. Aileron control is never used during a spin.

When the stick is in the full back position, and the plane has really stalled, press full rudder in the desired direction of rotation or spinning—to the left if a left spin is desired, and to the right if a right spin is desired. This causes the plane to "fall off" and start to rotate.



²In some light planes, it will be necessary to use some power; perhaps 1,000 to 1,200 engine R. P. M. on the entry to the spin. After the spin has started, however, the throttle is closed and the engine is allowed to idle through the spin. Ask your instructor concerning the plane you are using.

During the spin, maintain the controls in the same position as in entry. This means that the stick must be held **all the way back** and **full rudder held** in the direction of rotation.

Recovery from the spin requires coordinated control pressure opposite to that used in the entry. Apply *opposite* rudder pressure and *push* the stick sharply forward. This will stop the rotation and leave the plane headed downward in a rather steep dive. At this point the rudder is neutralized.

Recovery from the dive: Gradually apply back pressure on the stick, thus pulling the nose up to the level flight position. As the level flight position has been reached, ease the throttle open to cruising engine R. P. M. and cruising air speed.

Important!

Regardless of the type of airplane, recovery from spins is always accomplished in the same manner: Opposite rudder pressure, and then a moment later, forward stick. However, the amount of opposite rudder and the amount of forward stick and the length of time each must be applied varies widely from one type of aircraft to another. Some planes (most light planes) will recover after the controls are neutralized; others are designed so that they must be "flown out" of a spin, i. e., require considerable opposite rudder control and that the stick be *pushed* well forward of neutral. Always use as much of each control as needed to (a) stop rotation and (b) regain at least cruising air speed.

Slow and cautious movements during recovery are to be avoided, whereas brisk and positive operation of the controls brings about a normal recovery.

Do not push the stick too far forward or hold forward pressure too long or you will pick up too much air speed in the dive.

Recovery from the dive must be gradual, especially if an excess of air speed has been picked up in the dive. Remember that the abruptness of your pull-out is best sensed by your own weight as felt pushing down against the seat. The more pressure on your seat, the greater is the load on the wings. Don't make it too great!

Remember, under certain conditions of *temperature* and *humidity* it may be necessary to turn your carburetor heat on several minutes before closing the throttle to eliminate engine idling too slow and possible "quitting," caused by condensation of moisture or ice forming in the carburetor.

Occasionally check your engine idle speed during a spin.

To avoid stalling the engine during a spin it is recommended to increase the engine speed slightly above the normal engine idle R. P. M. during the spin. (Ask your instructor concerning this.)

27. ACCIDENTAL SPINS

Civil Aeronautics Bulletin No. 23, second edition. P. 162-165.

Accidental spins are demonstrated so that you may know what occurs when control pressures are applied **incorrectly**, and so that you may know how to make the proper recovery. You will be required to perform these maneuvers later; just now it is important that you know under what conditions they occur and how to sense their approach.

Spins From Climbing Turns:

If too much speed is lost in a climbing turn, the action of the controls becomes the same as in an intentional spin. Remember that, in a climbing turn, the stick is back and possibly rudder pressure is being applied. If the plane approaches stalling speed (which is somewhat higher in a turn than in straight flight), you have very nearly the same conditions that result in an intentional spin.

Keep plenty of flying speed in climbing turns.

If you think you are climbing too steeply, reduce the angle of climb.

Spins from Skidding Turns:

Skidding in turns results in great loss of air speed. If the plane reaches the stalling point while a large amount of rudder pressure is being applied, the nose drops. This can easily lead into a spin.

Never try a turn without banking. (Except up high to test what has just been said!)

Properly coordinate rudder and aileron pressures when entering into and recovering from turns.

Spins From Too Shallow A Glide:

If the nose is held too high in a glide, flying speed is lost, the plane approaches a stall and the nose tends to drop. The natural tendency at this point is to try to raise the nose by pulling back on the stick. This results in a complete stall and the plane is on the verge of a spin.

When flying speed is lost in too shallow a glide (as indicated by a falling nose or "sloppy controls"), ease the stick forward to regain it.

Spins From Gliding Turns:

A turn attempted in too shallow a glide places the plane in a position very similar to the one encountered in a climbing turn with too little flying speed. The plane is approaching a stall and rudder pressure is possibly being applied. You can understand that the plane needs very little coaxing to go into a spin under these conditions.

Again, when flying speed is lost in too shallow a glide, ease the stick forward to regain it.

Spins From Steep Turns:

As has already been discussed, the stalling speed of an airplane in a turn is higher than in straight and level flight, and the steeper the turn, the higher is the stalling speed. Therefore, in a steeply banked turn, the plane will spin at an air speed far in excess of what is ordinarily considered safe. Especially in low-horsepower planes, it is very easy to turn so sharply that the air speed falls below the stalling speed and a spin will result.

Recovery From Accidental Spins:

Recovery from accidental spins is exactly the same as from intentional spins. Review the material on spin recovery.

When practicing intentional spins, pay particular attention to the sensations you experience just before the plane spins. Remember them and use them always as warnings.

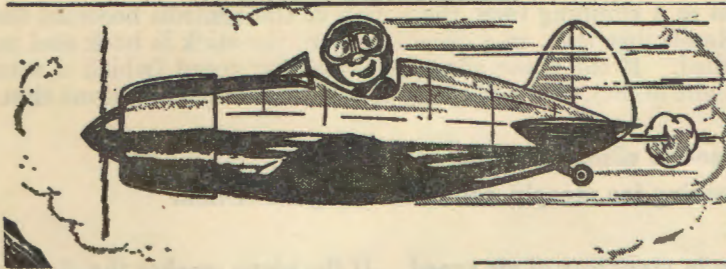
Learn to recognize an approaching stall and you will avoid spins. These are the warnings:

1. Ineffectiveness of aileron and elevator control, as indicated by necessity for greater movements of stick to achieve results.
2. Decrease in pitch and intensity of sound of air past the plane.

3. Increase in "laboring" and vibration of engine when power is on.
4. Glance at your air-speed indicator from time to time and make sure you have plenty of air speed for the maneuver you are flying. A few m. p. h. excess air speed is the best sort of life insurance. Even the best pilot cannot fly a plane below its stalling speed!

Always Keep Plenty of Flying Speed.

THE BEST WAY TO RECOVER FROM A SPIN IS TO AVOID GETTING INTO ONE.



SPEED
CREATES THE
LIFT REQUIRED
TO SUSTAIN
THE AIRPLANE

28. CROSS-WIND TAKE-OFFS

Civil Aeronautics Bulletin No. 23; second edition. P. 191.

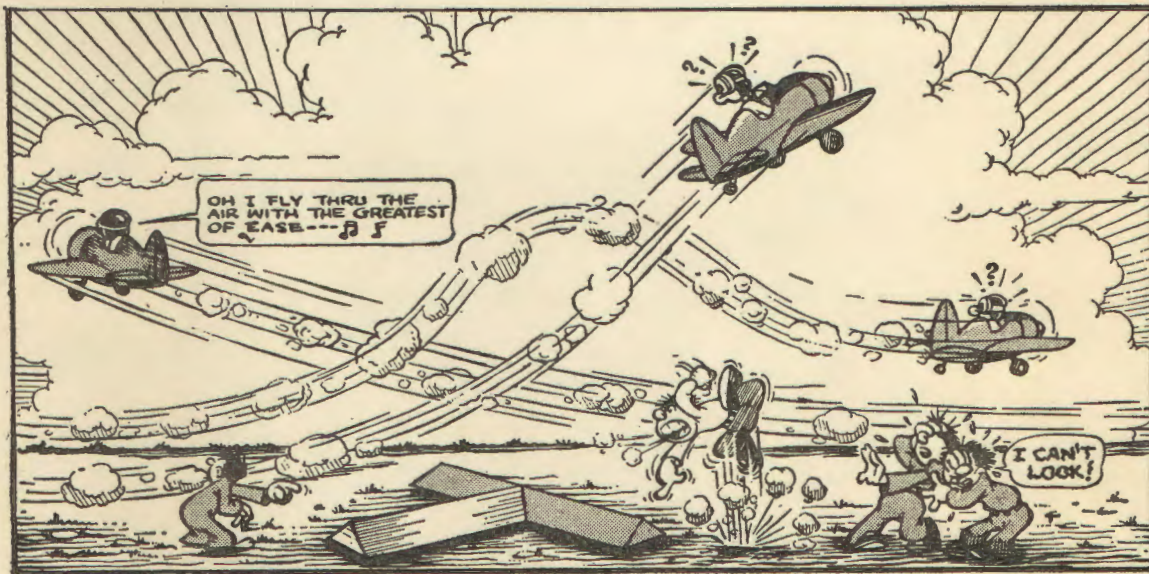
You should, of course, always take off into the wind if possible, but it sometimes becomes necessary to take-off cross-wind. It may be that you will be in a small airport some day with only one runway long enough for a safe take-off. So the cross-wind take-off is included in the training curriculum.

You will be required to perform this maneuver only a few times. Your instructor will demonstrate and explain it to you, so that it is well that you be prepared to understand what he's talking about.

This take-off differs from take-offs into the wind in the following respects:

1. **You attain a higher speed before actually leaving the ground, by keeping the tail slightly higher than normal.** This is to insure that the plane will stay in the air once it has left the ground. The plane drifts after it takes to the air in a cross-wind take-off, and if it settles again while drifting severe loads are put on the landing gear.
2. **It is usually necessary to lower the wing which is into the wind.** You do this by using aileron into the wind.
3. **Down-wind rudder is necessary to keep the plane heading straight on the ground,** because the plane will tend to turn into the wind.
4. **After the take-off, when you have gained about 50 or 75 feet of altitude, you may start a very gentle climbing turn into the wind (and into the traffic lane).** After this, the procedure is the same as for a normal take-off.

Be especially careful of traffic in cross-wind landings and take-offs. Other trainees will not be practicing this maneuver at the same time and you will be taking off in a different direction than the regular traffic.

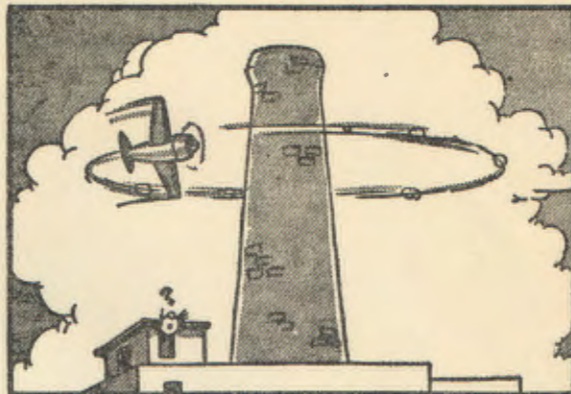


29. STEEP TURNS

Civil Aeronautics Bulletin No. 23; second edition. P. 195-197.

A steep banked turn is one in which the bank is more than 50 degrees. Most training planes now used, will not hold their altitude in a bank of more than about 60 degrees, so the steep banks will be between 50 and 60 degrees, or the maximum for the plane you are flying.

Before the turn is started, check traffic and then open the throttle fully. (Maximum engine R. P. M.) The amount of pressure applied to the controls to begin and recover from steep banks is the same as the pressure used in all other banks. You merely continue them longer until the plane has banked the desired amount. However, as the bank steepens, more back pressure must be applied to keep the nose up. This pressure is progressively increased as the bank increases. It is not released when the aileron and rudder pressures are, but is held just as in a shallow or medium banked turn. Because of the overbanking tendency, as in medium banks, a slight pressure must be held on the ailerons in the direction opposite to the turn.



The degree of bank should be held constant during the turn. If a correction is needed, it should be made using coordinated pressure on the controls.

To recover from a steep turn, the pressure is applied in the opposite direction on rudder and ailerons, and as the bank starts to shallow out, the back pressure on the stick is gradually eased off to keep the nose level.

During the turn, the stalling speed of the plane is increased. Therefore, steep banks should be entered with plenty of air speed and this speed should be maintained throughout the bank. This is one of the reasons why steep turns should not be attempted near the ground . . . especially without maximum (engine R. P. M.) power.

Maintain a constant altitude throughout the turns.

Remember: CHECK TRAFFIC IN ALL DIRECTIONS BEFORE STARTING THE MANEUVER

30. CROSS-WIND LANDINGS

Civil Aeronautics Bulletin No. 23; second edition. P. 191-192.

Like take-offs, landings should be made into the wind whenever possible. However, there may some day be an obstruction on the down-wind side of the field that you are trying to land in, making a cross-wind landing necessary.

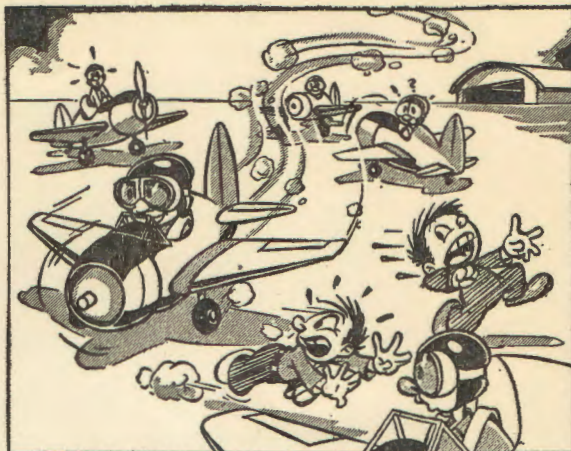
Cross-wind landings should be attempted only when the wind is rather gentle.

In some situations, only the approach need be cross-wind. After the obstacles which make the cross-wind approach necessary have been passed, and while the plane is still in the air, make a shallow turn into the wind and land in the normal manner.

There are three methods of making cross-wind landings:

- (1) The "slip method": In approaching the landing area, the up-wind wing is lowered just enough to counteract the drift resulting from the crosswind. This results in a straight path over the ground. You will have to use just enough bank and opposite rudder in the side slip to keep the plane headed in a straight path over the ground, allowing for drift and velocity of the wind. Just before contacting the ground, the plane is leveled off and sufficient rudder control applied to keep the plane rolling straight ahead. In strong winds, it may be necessary to keep the wing down and touch the up-wind wheel first.
- (2) The "rudder or crab method": In the approach, the plane is headed slightly into the wind and just a second before contact with the ground the opposite rudder (opposite to the wind) is applied to head the plane in the actual direction of its travel over the ground.
- (3) The "combination method" is a combination of the "slip method" and the "rudder or crab method." In this method the plane is first "slipped" from a higher altitude and when nearing the ground the "rudder" or "crab method" is used. There are variations of these methods of executing cross-wind landings, however, in either method the aim is to prevent the plane from contacting the ground while drifting sideways and thus prevent severe loads on the landing gear and possible "ground looping" of the plane.

Remember: OTHER PLANES MAY BE LANDING INTO THE WIND, THEREFORE, CHECK TRAFFIC IN ALL DIRECTIONS WHILE PRACTICING CROSS-WIND LANDINGS.



31. SERIES OF EIGHTS (ELEMENTARY No. 3)

In this maneuver you use the same type of landmarks that you used in making the No. 2 elementary eight, that is, the intersection of two landmarks such as roads or fence lines, which lie at right angles to each other. Your plane's path over the ground should describe a figure eight, the two loops of which lie along the cross-wind landmark. (See diagram.)

To begin the maneuver, start from a position on the up-wind side of the landmark which lies cross-wind (landmark B in the figure below), and over to the right or left of the intersection of your two landmarks far enough so that when you fly toward the intersection, your flight path will bisect the 90-degree angle between landmarks A and B, as in the diagram below.

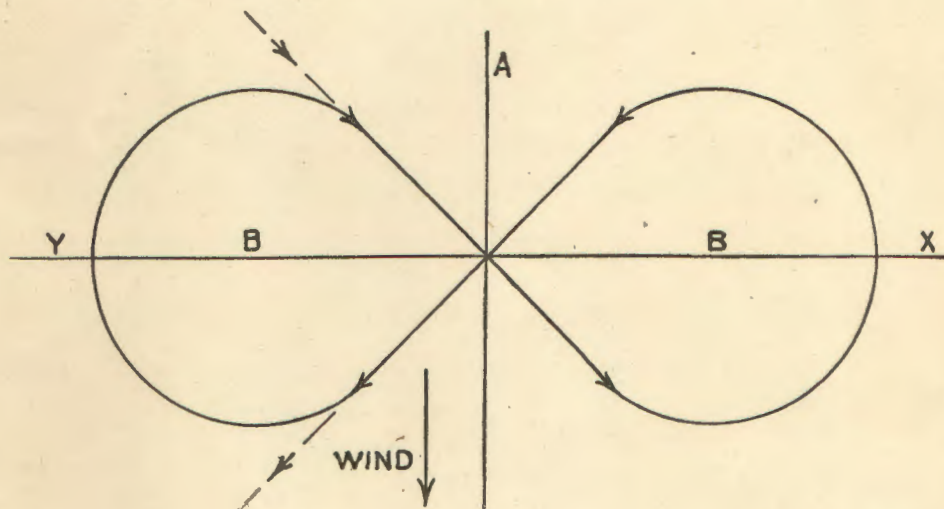
Then fly directly towards the intersection. When you reach the intersection continue the level flight for a short interval, and then start the first loop of your eight.

Vary your bank so that your plane will cross the road at a right angle at the end of the loop of your eight (position X in the diagram). Then continue your turn, and plan your recovery so that you will come out of your turn headed toward the intersection, and will have an interval of straight and level flight before passing through the intersection.

After you pass the intersection, continue straight and level flight for a short interval, and then make the other loop of your eight. Again be certain that your plane is at right angles to the road at the end of the loop of your eight (position Y in the diagram).

Your flight path through the intersection of the landmarks, between the loops of your eight, should approximately bisect the 90-degree angle between these landmarks. Remember, that in order to maintain this flight path, you will have to "crab" a little into the wind.

REMEMBER THE GENERAL PRINCIPLES YOU LEARNED EARLIER REGARDING VARYING THE BANK TO CORRECT FOR DRIFT.



32. "EIGHTS" AROUND PYLONS

Civil Aeronautics Bulletin No. 23; second edition. P. 206-207.

Pylon Eights (or eights around pylons) is a maneuver in which the plane is flown around two landmarks (or pylons), the flight path having the shape of a figure "8", both loops of the eight being identical and uniform distance from the pylons maintained throughout the turns.

Two large trees, intersections, or other landmarks are selected that are directly cross-wind and far apart enough to allow a short straightaway flight between turns.

The maneuver is started by flying at an altitude of approximately 600 feet directly down-wind toward the point halfway between the pylons. When the plane reaches the down-wind side of the pylons, start a 45- to 50-degree-bank turn, to the left or right into the wind, around the first pylon, keeping the distance from the pylon the same throughout the turn by varying the degree of bank to compensate for drift.

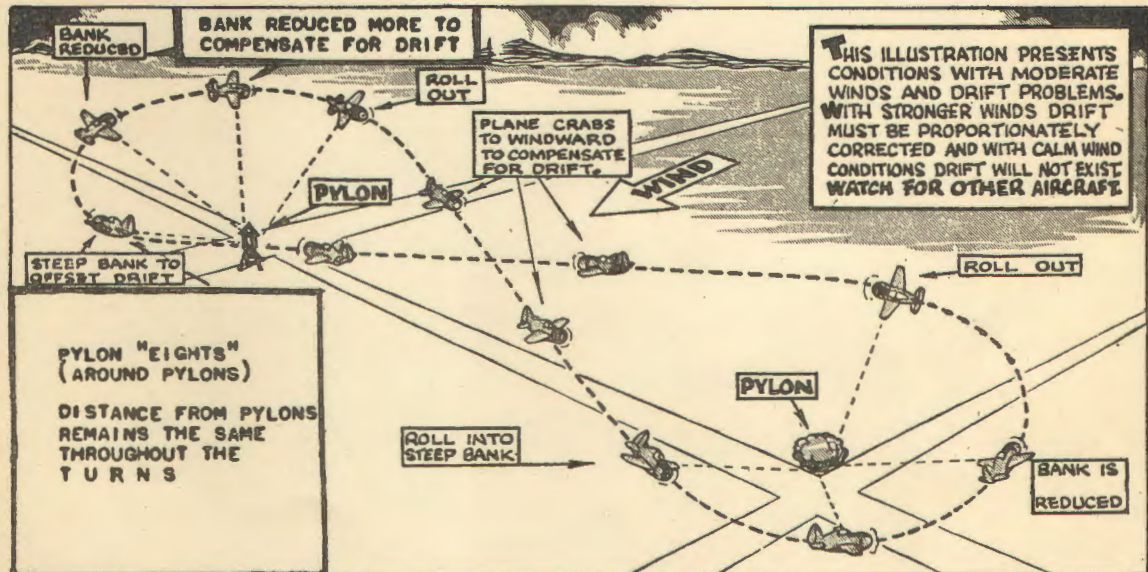
As the plane approaches the opposite side of the pylon (the up-wind side) roll out of the turn and head the plane to the point opposite the other pylon (on the down-wind side) the same distance from the pylon as the first turn was started around the first pylon.

When opposite the second pylon (on the down-wind side) start a turn around this pylon, keeping the distance from the pylon the same through the turn by varying the bank to compensate for drift.

When the turn is completed head the plane toward the opposite pylon for a second turn around this pylon.

Remember to start and stop your turns around the pylons so that both loops of your "8" will form the same path over the ground and the distance from the pylons remains the same through the turns.

Care must be exercised in compensating for drift in the turns and during straightaway flight between pylons.



33. "EIGHTS" ON PYLONS

Civil Aeronautics Bulletin No. 23; second edition. P. 248-254.

The purpose of this maneuver is to enable the trainee to acquire precision in handling the plane in positions with which, up to now, he has been unfamiliar. They all require a thorough knowledge of the effect of the controls, relaxation, good "feel" of the plane and proper timing.

The pylon eight or the eight on pylons is a maneuver in which the airplane is flown around two pylons, the flight path having the shape of a figure "8" and the turns being such that some portion of the airplane, such as the lower wing tip, is held continuously on a line from the pilot's eye to the pylon. This line should be parallel to the lateral axis of the airplane.

This maneuver differs from eights around pylons in two important respects. It will be recalled that in the eights "around pylons" the distance from the pylons remains the same, while in the eights "on pylons" the distance from the pylons varies if there is any wind. This is the first point of difference.

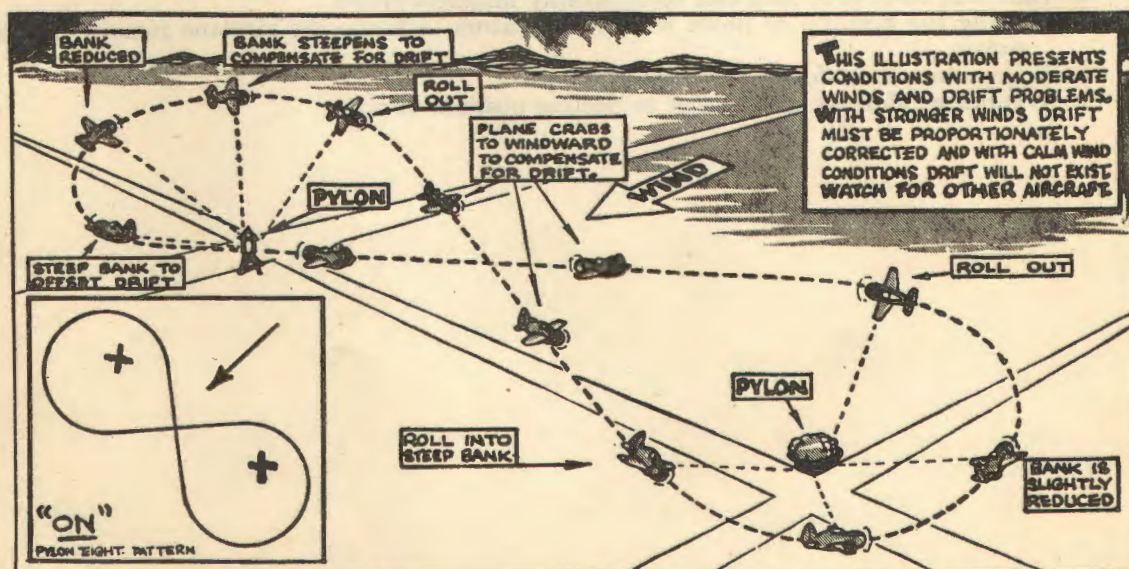
The second point is that the bank varies in quite a different way, increasing as the distance from the pylon decreases and decreasing as the distance from the pylon increases.

Since the airplane is closer to the pylon on the windward or up-wind side, it is obvious that the bank must be increased in order to hold any given point on the wings in line with the pilot's eye and the pylon. Conversely, on the down-wind side, the bank must be shallower because the airplane is farther away from the pylon. As a result, the degree of bank, the radius of the turn, and the distance of the airplane from the pylon continuously are changing.

On pylon "eights" are considered the most difficult type of eight since their execution is affected by the speed, the altitude, and the angle of bank as well as the other factors which affect all eights. If the "on" pylon eight is to be performed perfectly, there is only one altitude for a given air speed, and this altitude is the same for all angles of bank.

In performing this maneuver, however, you must remember that steep banks demand high speeds to prevent stalling. For medium and gentle banks, on the other hand, you will not want to use unnecessary speed, because of the excess loads on the engine. Therefore, it is best to do the medium and gentle pylon eights at cruising speed, with the same altitude, and then do the steep pylon eights at a speed that is safe for them and consequently at a higher altitude. The altitude required for any given speed can be found by trial, in which also the above rules can be checked.

Reference marks for sighting parallel to the wing span are not well defined on many airplanes and usually have to be figured out with some care by measurements on the ground before starting the maneuver. The ground objects should be selected in the same manner as for eights around pylons, or the same pylons can be used if desired (provided they are objects of about the same height), and all turns should be started into the wind as before.



The starting point should be far enough to the side of the pylon so that when the airplane arrives at a point on a line with it and the bank is assumed, the pylon will appear in the center of the gap and midway between the two outer struts of a biplane. In a monoplane usually either the wing tip is used or the area bounded by the V-struts, the wing, and the "jury strut."

The bank must not be started until the wing can be lowered and the pylon appear in this position.

The following rules will assist the trainee in making the proper corrections:

1. Assuming that the altitude is correct, if the pylon appears to move toward the upper wing or toward the leading edge, decrease the bank slightly to retain or regain the desired position.
2. If a pylon appears to move toward the lower wing or trailing edge, increase the bank slightly to retain or regain the desired position.
3. The more quickly the pylon's tendency to move in any direction is sensed or observed, the less the correction necessary to hold the desired position.

In order to accomplish the objective of this type of eight, the pylon must be watched constantly and the airplane flown accurately through the use of kinesthesia or "feel," with visual perception not devoted primarily to it. The eyes must be kept on the pylon, and the attitude of the wing tips also may be observed, as well as their seeming action with reference to the pilot. This will indicate the attitude and action of the nose as well as the bank. Other senses will warn of approaching slips and skids. The amount of initial bank should be about 45 degrees.

Execution—Select two pylons located so that an imaginary line connecting them is at 90° to the wind. Fly parallel to this line at the altitude previously determined as suitable for the speed to be used in making the turn and at such a distance from the pylons that the turn can be made on it properly. When approximately in line with the first pylon, lower the wing until the sighting point strikes the pylon, at the same time beginning a turn into the wind.

Fly around the pylon with the pylon constantly in line with the sighting point until the position for recovery has been reached. Level the wings and, with due allowance for drift, fly to the proper location to start the turn around the second pylon.

Common Faults:

1. Usual faults in turns.
2. Starting turn too soon or too late.
3. Starting turn at wrong altitude.
4. Starting turn at incorrect distance from pylons.
5. Coming out of turn too late.
6. Incorrect throttle setting and consequently incorrect speed.
7. Moving the nose up or down with the elevators to make the airplane remain on the pylon.
8. Failure to correct for drift between pylons.
9. Watching pylon too closely and neglecting position of nose.



34. SERIES OF TURNS

This maneuver, known as "Series of Turns," embodies nothing which you have not already learned, but it will be one of the required maneuvers on your part, because it calls for planning, for holding altitude, and for precision.

This series of turns is done at 1,500 feet, and the excellence of your performance depends on the accuracy and precision with which you make the turns, and on the degree to which you hold your altitude constant.

It is necessary that you memorize the order of this series of turns, which is as follows (refer to diagram):

1. Two gentle 90-degree turns; first one into the wind, then one cross-wind.
2. Two medium 180-degree turns; in opposite directions, started when flying cross-wind.
3. One gentle 90-degree turn into the wind.
4. Two steep 360-degree turns made in opposite directions, each started when flying directly into the wind.

First: Choose two roads or section lines for your landmarks. They must be at right angles to each other, and the first landmark must be cross-wind.

Second: Begin the maneuver by flying cross-wind, down your first landmark. As you approach the intersection of your second landmark, look around for other planes, and then make a gently banked 90-degree turn into the wind.

Third: Fly straight and level directly into the wind for a few seconds, look for other planes, and make another gentle 90-degree turn in the opposite direction from the first turn.

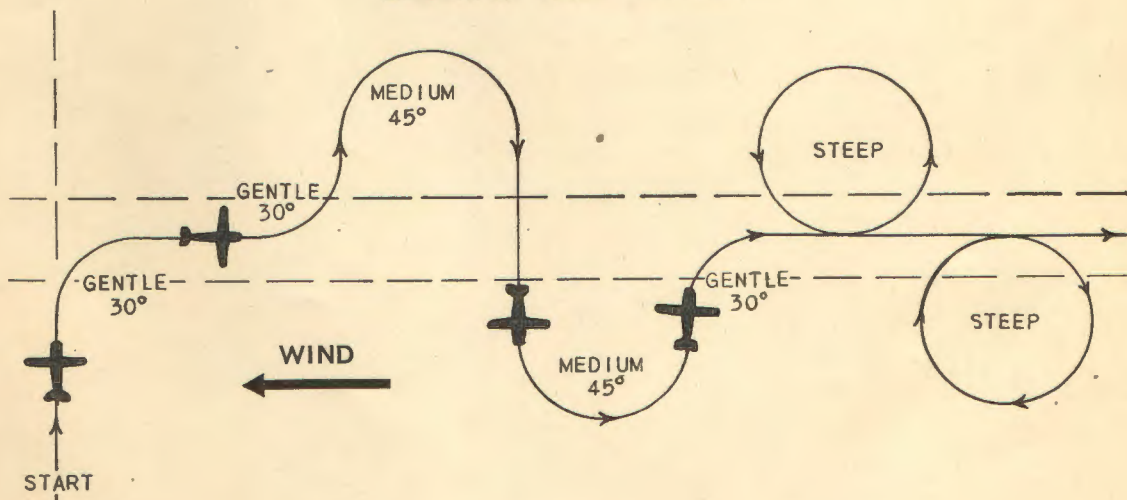
At This Point You Will Again Be Cross-Wind And Parallel To The Original Landmark.

Fourth: Fly straight and level for a few seconds, and after checking for other planes, make a medium 180-degree turn into the wind, using not more than a 45-degree bank. Again fly straight and level cross-wind for a few seconds, look for traffic, and make another medium 180-degree turn in the opposite direction.

As You Finish Your Second 180-Degree Turn, You Should Again Be Flying Cross-Wind, Parallel To Your Original Landmark.

Fifth: Check for planes, and then make a gentle 90-degree turn so that you are again flying into the wind, parallel to the road or section line which is your second landmark.

SERIES OF TURNS
EXECUTE AT 1500' ALTITUDE



It is important that each turn be completed exactly in line with your landmarks. In other words, they are to be precise 90, 180, and 360 degree turns.

Remember: During the time you are flying straight and level between the various turns, it may be necessary for you to “crab” into the wind in order to keep your flight path parallel to your reference landmarks.

LOOK IN ALL DIRECTIONS FOR OTHER PLANES, PARTICULARLY IN THE DIRECTION YOU WILL BE TURNING!

35. 720-DEGREE STEEP TURNS (Maximum Bank)

Civil Aeronautics Bulletin No. 23; second edition. P. 204-206.

This maneuver consists of flying two complete circles at a constant altitude and constant degree of bank. Its purpose is to help you acquire coordination and accuracy in entering into and recovering from turns.

Your altitude should be at least 1,500 feet.

Your degree of bank should remain constant at 50 to 60 degrees, or the maximum for type of plane used. You should feel a sharp "bump" during the second 360-degree turn. This will be caused by a propeller wash made during the first turn. If you don't feel it, either your altitude or your radius of turn has varied. In either case, you have not performed the maneuver correctly.

Full throttle is used for the maneuver. Since a good portion of the wings' lift is used to counteract centrifugal force and due to the higher stalling speed in a steep bank, you must use all the power available to maintain your altitude.

Pick a landmark before starting. You will be able to judge your turns better if you choose some straight landmark, such as a road, to go by. Find one that is directly cross-wind, and do the maneuver on the down-wind side of it, starting the turn into the wind. In this way you can use the road as a guide to help you recover at the proper time and in the correct direction.

To Execute the Maneuver:

Fly down-wind of your landmark and parallel with it at an altitude of not less than 1,500 feet. **Check the air around you for other planes.**

Open the throttle fully.

Start a bank and turn into the wind. Your bank should be about 60 degrees, or as steep as can be maintained without losing altitude.

Continue the turn through two complete circles, or 720 degrees.

Recover so that you will be flying parallel with your landmark. You will have to anticipate in your recovery, so as not to overshoot.

Cautions:

Be certain to coordinate properly. Remember that you don't use more aileron pressure for a steep bank—you just hold the pressure longer. Make your entrance and recovery smooth.

Hold your bank constant. There is very little overbanking tendency in a steep turn so very little opposite aileron will be necessary.

Hold the nose of the plane up. You will have to use considerable back pressure in order to "tighten up" the turn and not lose altitude.

But remember that the plane can and will stall in a turn as in any other position if too much back pressure is applied too long.

36. SPIRALS

Civil Aeronautics Bulletin No. 23; second edition. P. 207-209.

A spiral is a steeply banked gliding turn maintained through several revolutions. This maneuver enables you to lose altitude while circling around some point on the ground. If your engine quit, and you wanted to land on a field almost directly below you, you can see how the spiral would be useful in coming down to a position from which to begin your landing approach.

In practicing this maneuver, start the spiral at about 2,000 feet. This will give you enough altitude to make 4 or 5 turns before coming out of the spiral at 1,000 feet.

Check traffic in all directions.

To start the maneuver, head into the wind, far enough to the left of the selected point on the ground so that you can see it from the window of your plane without leaning in the seat.

Apply carburetor heat before closing throttle.

Close your throttle, and start a gliding turn around the point on the ground.

Keep a constant distance from the point throughout the spiral. That is, make the point on the ground the center of the circle through which you turn. In order to make your ground path circular, you will have to vary your bank to correct for drift, just as you did when practicing "8's" and S-turns. Remember, as you head up-wind, shallow out your bank; as you head down wind, steepen up your bank.

About every 20 seconds, open throttle and clear engine of accumulated gases.

The average bank during this maneuver should be between 50 and 60 degrees. That is, bank about as steeply as you did in your 720-degree power turns. However, when practicing this maneuver, on your first few trials it is sometimes a good idea to use a shallower bank (about 45 degrees) until you get the "feel" of the maneuver. Then, after you get used to the maneuver, you can spiral using a steeper bank.

Maintain a constant gliding speed. Since in turns the stalling speed of your plane is raised, your speed will have to be higher than the normal gliding speed of the plane. But be careful not to hold the nose too low, or a spiral dive will result. Check your air-speed indicator and maintain an airspeed about 10 m. p. h. higher than normal gliding airspeed.

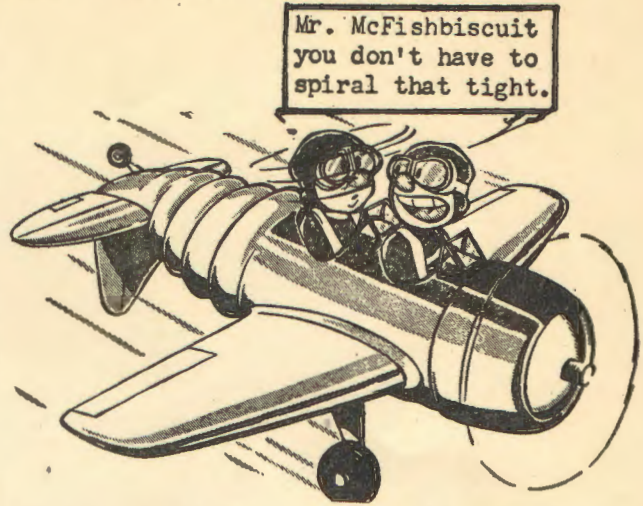
Coordinate your controls in the entry and recovery. One of the purposes of this maneuver is to develop skill in executing gliding turns. Be careful not to skid or slip especially in the recovery.

Pick some reference points on the ground besides your spot, so that you will not lose your sense of direction or orientation. Roads, trees, or other landmarks usually serve this purpose. By keeping track of these landmarks during the spiral, you will always be aware of the direction in which you are heading.

Come out of the spiral, and resume the normal glide at 1,000 feet.

Never continue your spiral below 1,000 feet.

Remember to clear engine about every 20 seconds in the glide and check traffic.



37. POWER LANDINGS

Civil Aeronautics Bulletin No. 23; second edition. P. 209-210.

In a normal landing, the plane is partially stalled just before it touches the ground. As you know, when the plane is stalled, the controls lose most of their effectiveness and the plane is difficult to handle. Thus, in a high and gusty wind you may not be able to control the plane during a normal landing.

Under these conditions, the power wheel landing is extremely useful, since the plane is literally "flown onto the ground" with sufficient air speed to enable the pilot to have complete control of the plane throughout the maneuver. The approach is made with power on, the plane lands on its front wheels only and rolls along on the ground in a tail-high position, until the pilot closes the throttle and puts the tail on the ground.

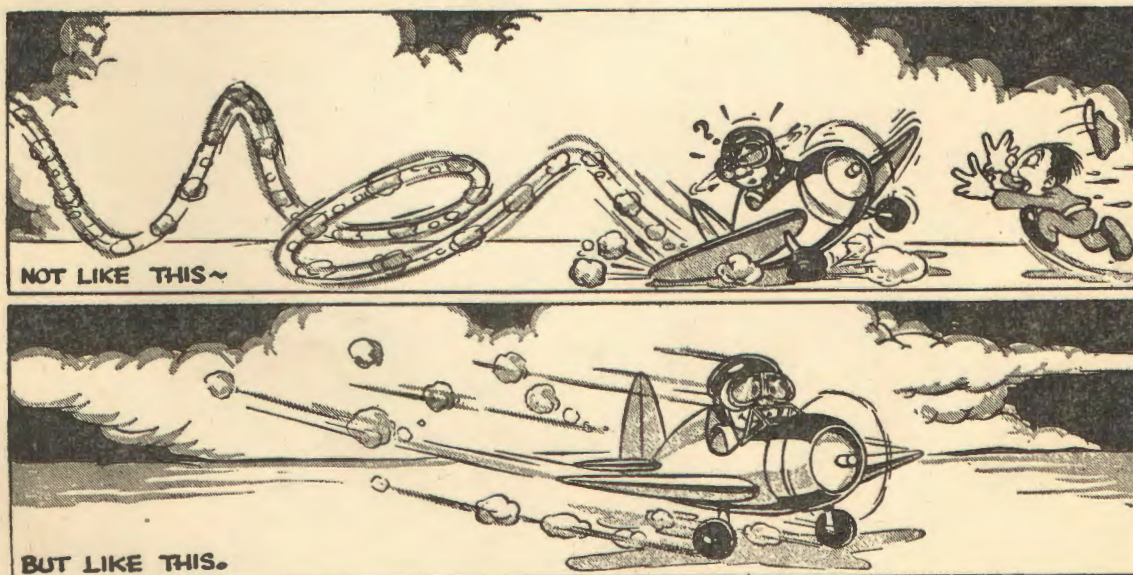
The approach to a power landing is made with power on, and consequently the angle of the glide during the approach is somewhat flatter than during the normal glide. When you begin the approach, throttle the engine back slightly, and place your plane in a gliding angle somewhat flatter than a normal glide.

During the approach, especially in rough air, keep your air speed about ten miles an hour faster than the normal gliding speed of the plane. If you are gliding too fast, raise the nose, or decrease the engine R.P.M. depending on whether or not you want to lose altitude more rapidly, or more slowly. If you are gliding too slowly, increase your gliding angle, or give the engine more R.P.M.

As you approach the ground, level off and fly straight and level about two feet off the ground. Use just enough engine R.P.M. to maintain sufficient speed to keep the plane from settling.

Then, gradually ease the stick forward until the wheels touch the ground. Hold the wheels on the ground with a slight forward pressure on the stick, and taxi along on the ground in this tail-high position. You will be taxiing with the tail in the air, fast enough to be flying, except for the fact that in this tail-high position the wings are at a zero angle of attack, and therefore have little lift. Thus a sudden gust of air will not lift the plane off the ground, and the propeller blast on the tail gives excellent rudder and elevator control.

When you want to put the tail on the ground decrease the engine R.P.M. slowly, thereby slowing up the taxi speed, and gradually let the tail down. The plane will then roll to a stop.



Wheel landings require more space than normal landings. Therefore if there is any question in your mind regarding whether or not you will overshoot the field on your approach, open the throttle, and go around again. In actual practice, the wheel landing is used only when the wind is strong.

Under these conditions you need to worry less about space needed, since in a 25- to 30-mile wind your actual ground speed will be only 15 or 20 miles per hour as you touch the ground.

Don't push the stick forward too suddenly or you will hit the wheels too hard and bounce (as you probably did several times in learning to land). Too much forward pressure on the stick will cause a nose-over, so be sure to practice this maneuver first with your instructor.



38. FORWARD SLIPS

Civil Aeronautics Bulletin No. 23; second edition. P. 211-213.

The forward slip is a maneuver which enables you to lose altitude rapidly, and at the same time to maintain your original flight path over the ground. During the slip, one wing is lowered, enough opposite rudder is applied to turn the nose slightly away from the low wing, and the plane moves sideways through the air without change of flight path. The increased drag (resistance of the plane to its movement through the air) when the plane is in this position prevents an increase in air speed, even though the angle of descent is greater than in a normal glide.

The advantages of a forward slip are that it enables you to shorten and to steepen your landing approach without increasing your forward speed or changing your flight path. It also allows a clear view of the landing area during the approach.

The forward slip is particularly useful in forced landings. Since it enables you to lose altitude rapidly without increasing your air speed, you can come in over obstructions (trees, wires, etc.) then lose altitude rapidly and land in a small field. Furthermore, it is valuable insurance against undershooting a field, when you have no engine to help you. Under such circumstances, you can intentionally make your approach with too much altitude. Then, when you are close enough to the field to judge that there is no danger of undershooting, you can lose this excess altitude in a forward slip.

To start the maneuver, close your throttle and assume a normal glide. If it is left open, the engine will vibrate excessively, since the air will not strike the two blades of the propeller at the same angle.

Then lower one wing slightly, and hold aileron pressure to keep the wing lowered.

As you lower the wing, hold enough opposite rudder to keep the plane from turning from your original flight path. Remember, in a forward slip, although the plane is following your original flight path, the nose is not pointed in the direction in which you are moving.

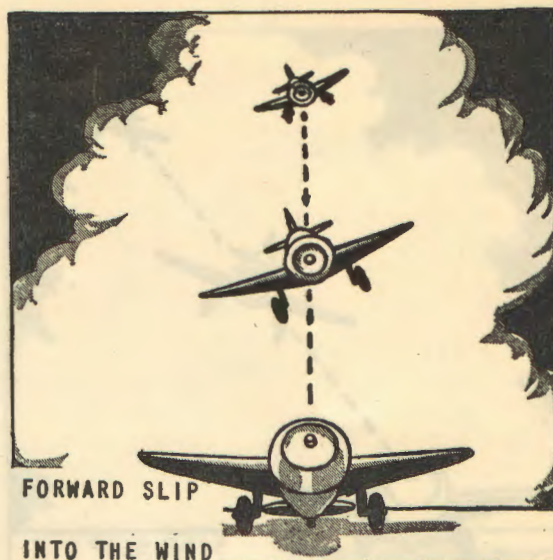
Now raise the nose above the normal glide position by exerting back pressure. Your air speed during a forward slip should be the same as during a normal glide. If you don't raise the nose, you will gain excessive air speed, which will increase the length of your glide, and destroy the usefulness of the maneuver. But don't raise the nose too high or the plane will stall in full readiness for a spin.

To recover, use enough aileron pressure to raise the low wing, and gradually ease off your rudder pressure, at the same time, lower the nose and recover to the normal glide position.

After a little practice you will be able to coordinate opposite control pressures and perform the maneuver smoothly.

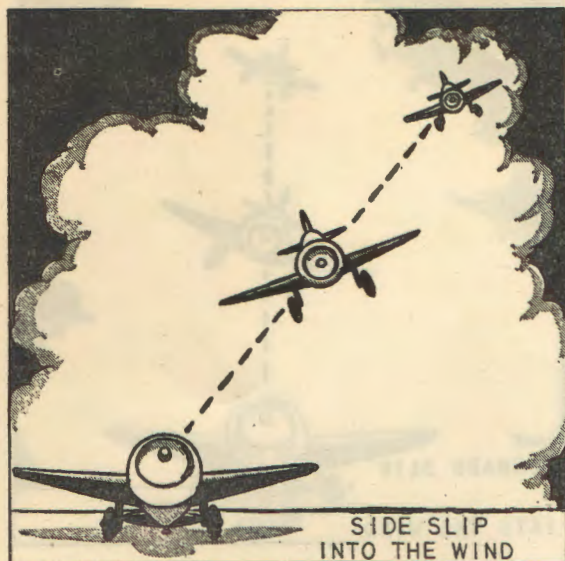
Common faults are:

1. Failure to raise the nose, resulting in a nose-down slip, with an increase in speed.
2. Releasing rudder too quickly.
3. Insufficient rudder pressure so that direction of motion is changed and the slip becomes a side slip instead of a forward slip.
4. Holding the nose too high, causing the plane to stall.



39. SIDE SLIPS

Civil Aeronautics Bulletin No. 23; second edition. P. 213-214.



The side slip differs only slightly from the forward slip. The principal difference lies in the flight paths followed by the plane during these two maneuvers.

In a forward slip one wing is lowered, the nose moves slightly in a direction opposite to that of the lowered wing, and the plane slips sideways through the air, along the original flight path of the plane.

In a side slip the longitudinal axis of the plane is held *parallel* to the original flight path, and when one wing is lowered, the plane moves sideways through the air in the direction of the lowered wing, *away from* or at an angle to, the original flight path.

The sideslip is executed in essentially the same manner as the forward slip.

One wing is depressed, and as the plane starts to turn in the direction of the low wing, enough opposite rudder pressure is applied to keep the nose of the plane headed in the *original direction*. The flight path will be

forward, down, and to the left (or right) in the direction of the low wing.

As the wing is depressed, the nose of the plane should be raised enough so that the normal gliding speed is maintained. Keep glancing at your air-speed indicator. It will probably be necessary to raise your nose slightly higher than you raised it in a forward slip, and then, to ease forward on the stick enough to prevent the plane from turning.

This maneuver, like the forward slip, requires opposite movement of stick and rudder. This represents a different type of coordination than you have been practicing.

"Forward and side slips" can be done into the wind or cross wind. If they are executed cross wind the "drift" will affect their flight path over the ground according to the velocity of the wind.

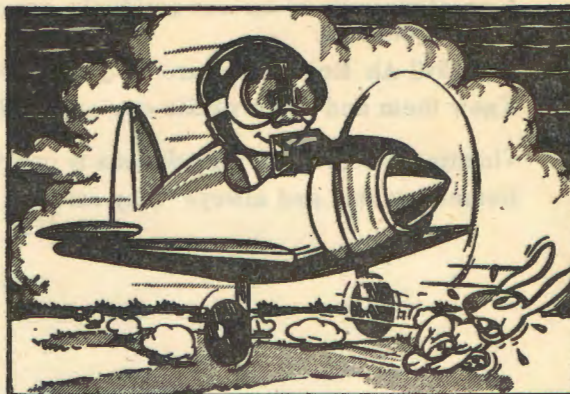
By combining the *side and forward slips* we get a "turning slip" or "spiral slip", in which a side slip is begun when the plane is flying at 90 degrees to the wind with the low wing headed up wind. By easing off "top" rudder pressure the plane is allowed to turn into the wind and assume the position of a forward slip. From this point on, the control pressures pertaining to the forward slip apply.

40. "DRAGGING" AREAS

Civil Aeronautics Bulletin No. 23; second edition. P. 214-215.

This maneuver is used to enable you to look over a strange field on which you propose to land. It is particularly useful when you are running short of gas, or when you are forced to land on a field other than an airport because of approaching bad weather during a cross-country flight, or when lost.

"Dragging" an area consists in flying over the field, to one side of the area in which you intend to land, at an altitude sufficiently low that you will be able to determine the size of the field in relation to the landing characteristics of your plane, the condition of the field's surface, and the presence of obstacles in your intended landing path which would not be visible from a greater altitude.



When you have selected the field in which you intend to land, circle it at an altitude of 500 feet. During this circuit pay particular attention to the field's size, its contours, approaches, surface conditions, and the wind direction. Plan your approach so that you will have the longest run possible after landing, taking into consideration the wind, and other factors.

Then make a more careful inspection of the area in which you intend to land by "dragging" the area.

Approach the field, headed into the wind, in a power-on glide. Since your glide is more shallow with power on, it will have to be started either farther from the field, or with less altitude, than would a normal approach.

Fly up wind over the field, to one side of the intended landing area, at 30 to 50 feet altitude, keeping your air speed well above the stalling speed of the plane. Carefully examine the intended landing area. Look for stumps, holes or soft spots in the field, other obstructions, and note with particular care the field's inclination. Repeat the maneuver if necessary, until you are certain that the field is suitable for landing.

Be certain that you are not flying so low that you will be unable to clear obstacles, such as trees or buildings at the far end of the field.

In deciding whether or not the field is satisfactory, and in planning your actual approach for landing, remember: YOUR INSTRUCTOR PROBABLY WILL HAVE TO FLY THE PLANE OUT OF THE FIELD. THEREFORE be certain that there are no tall trees or other obstructions on the up-wind side of the field.

If the field is sloping, it is usually better to land down-wind and up-hill rather than up-wind and down-hill, unless the wind is very strong.

In general, plan your approach so that you will have the longest run after landing, taking into consideration the wind, and other factors.

Make several practice approaches before making the actual landing.

This maneuver will be demonstrated by your instructor, and you will not be required to practice it solo. But remember how the maneuver is done as you might have occasion to use it some time.

If an occasion arises when you must make an emergency landing in a field due to bad weather, becoming lost, or for other reasons, Don't Attempt to take off again from this field.

Call your instructor or the airport by telephone and explain your difficulty to them.

Your instructor and the owner of the plane will have a greater regard for you in making this decision, than if you attempted a take-off which resulted in an accident and personal injury to yourself and damage to the plane.

A great majority of serious accidents are caused by the pilot violating one or more of the Civil Air Regulations.

The Civil Air Regulations are for your safety and the safety of your passengers.

Know them and don't violate any one of them regardless of how trivial they may seem to you.

Violating the Civil Air Regulations is one way to keep from getting old.

Remember this and always "play safe."

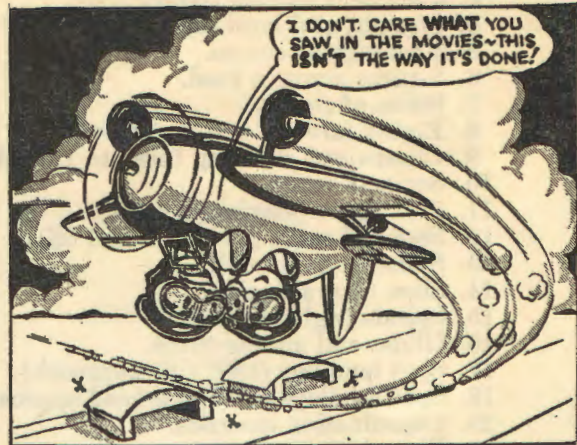


41. CHECK FLIGHTS

Civil Aeronautics Bulletin No. 23; second edition. P. 242-243.

At the end of your training period you will be given a flight test by CAA personnel. Furthermore, at intervals *during* your training, you may be given periodic "check flights" by some person other than Administration personnel.

These "check flights" are examinations. Their purpose is to determine how well you have learned to maneuver an airplane. As in any other examination, how well you do on the "check flight" depends upon how well you are prepared. If you have taken your instructions seriously, if you have practiced conscientiously during your solo flying, and if you understand the fundamentals you learned in ground school, you will not need to worry about your "check flights."



Some trainees get "inspectoritis," and "blow up" during their "check flight." Sometimes this results from a feeling of unpreparedness. Often, however, the simple fact of having the check pilot in the front seat makes a trainee "jittery."

Remember that the check flight is just like any other flight. The check pilot will merely ride along while you fly the plane through a series of maneuvers. Unlike most examinations, you will know the series of maneuvers which the check pilot will require. You will have practiced them many times, both with your instructor and solo. You will know what is coming, and there is no reason why you should not fly as well with the check pilot as you did while practicing. The check pilot is a human being, he was once a trainee himself, and would probably rather give you a good mark than a poor one.

When practicing the check flight maneuvers solo, imagine that the check pilot is sitting in the front seat and give yourself a "check flight" from time to time. During the "check flight," the check pilot will say little or nothing, so the practice situation won't be wholly different from the actual flight.

For some of the check flights you will be required to memorize the sequence of the various maneuvers, and to go through the series without directions from the check pilot. If this is the case, be certain that you know the sequence of the maneuvers. This should be easy, since you will have flown the series both with your instructor, and solo many times. The sequence of maneuvers for the final "check flight" is given on a following page. At any given point in your flight training, practice until you are proficient in all the maneuvers in this list which you have learned up to that time.

The emphasis during the check flights is on precision! This means you must plan ahead. All maneuvers will be done with reference to some landmark on the ground.

During the maneuvers, always be aware of the position of your plane in reference to these landmarks. For instance, while you are making a turn, estimate where your turn is to be completed, and how you will have to vary your bank in order to recover in the proper position in regard to your landmark. During the maneuver, and during the straight and level flight between maneuvers, plan ahead, and decide how and where you will start the next one.

Don't get rattled and hurry through the maneuvers. The sequence in which the maneuvers will be flown has been arranged so that the most flying can be done in the least time. But be deliberate. Enter and recover from your maneuvers decisively, and unless directed otherwise, fly straight and level for a few seconds between maneuvers while you "pull yourself together."

Again remember, the check flight is just like any other flight.

Following is the sequence of maneuvers for the final check flight:

1. Taxiing.
2. Take-off.
3. Judgment leaving traffic.³
4. Straight and level flight.
5. Rectangular course.
6. S-turns across a road.
7. Series of eights.
8. Eights (around and on pylons).
9. Climbs and climbing turns to 1,500 feet.
10. Series of turns.
11. 720° turns (maximum bank).
12. Series of stalls (power on and off).
13. Spins (as required).
14. Slips (forward, side).
15. Spirals (right and left).
16. Glides and gliding turns.
17. Spot landings (180° side approach).
18. Spot landings (180° overhead approach auxiliary field).
19. Coordination exercises.
20. Forced landings.
21. Judgment entering traffic.³
22. Planning.³
23. Alertness.³



³ These items are not maneuvers to be flown in the check flight but aspects of your piloting behavior which will be rated by the check pilot

42. QUESTIONS

Types of Questions Which Trainees Should Be Able To Answer Before Each Maneuver:

1. FAMILIARIZATION WITH THE PLANE:

What is a line inspection?
When and by whom is a line inspection made?
Why is the engine idle R. P. M. very important?

2. STARTING THE ENGINE:

Why is it necessary to have the plane chocked before starting?
What should be the first thing that you do after you get into the plane?
What is the proper method of indicating that the switch is "on" or "off"?
Where should the control stick be held when the engine is being started?

3. TAXIING:

What is the most important control used in taxiing? Explain.
How sensitive to rudder movements is the plane while it is taxiing?
At what speed should you taxi?
What sort of a course should you follow while you taxi? Why?
Before you start to take-off, in which direction should you turn your plane? Why?
Where should you hold the control stick when taxiing into the wind?
Against the wind? Why?

4. EFFECT OF CONTROLS:

How do you lower the left wing?
How would you raise the nose of the plane? What control surfaces are involved?
What is the correct manner of holding the control stick?

5. STRAIGHT AND LEVEL FLIGHT:

How do you maintain a straight flight path over the ground?
At what position should the throttle be set for straight and level flight (R. P. M.)?
How can you tell the angle of climb?
How can you tell when your wings are level?
How do you raise a wing that is low?
What happens to the control surfaces if you release the stick and rudder while in flight?

6. TURNS:

Why is it necessary to hold back pressure in a turn?
Where should you look before starting a turn? Why?
After a turn has been established, why must you use opposite aileron?
Why must you "ride with the plane" during a turn?
What are the usual causes of a skid in a turn?—of a slip?

7. ELEMENTARY COORDINATION EXERCISES:

What degree of bank do you use in this exercise?
Through how great an arc are the turns made?

8. NORMAL CLIMBS:

Where should you look before making a normal climb?
What is the engine R. P. M. setting for a normal climb?
What is the difference between a normal climb and a maximum climb?
How do you recover from a normal climb?
What are the indications that you are climbing too steeply?

9. NORMAL GLIDES:

How do you establish a normal glide?
Where should you look before starting a normal glide?
Is the throttle ever opened during a normal glide? Explain.
How can you tell when you have a normal angle of glide?
How do you recover from a normal glide?

10. CLIMBING TURNS:

- Where should you look before you start a climbing turn?
- What is the engine R. P. M. in a climbing turn?
- What is the angle of climb in a climbing turn? How does it compare with a normal climb?
- What is the engine R. P. M. setting for a maximum climbing turn?

11. GLIDING TURNS:

- How is the recovery from a gliding turn different from a turn with power?
- How does the gliding angle of a gliding turn differ from a normal glide?
- How is the throttle used in a gliding turn?

12. CONFIDENCE-BUILDING MANEUVERS:

- What happens if the throttle is closed while the plane is flying "hands off"?
- What happens when the rudder alone is used to turn the plane?
- What happens when the ailerons alone are used to turn the plane?

13. ADVANCED COORDINATION EXERCISES:

- In what two ways do you provide for more lift in a climbing turn?
- Why is the gliding angle made steeper during the gliding turn?
- Through how great an arc are these turns made?

14. SERIES OF STALLS:

- Under what conditions is a stall safe?
- At what air speed does your training plane stall?
- Can an airplane be stalled when in a dive?
- What are the symptoms of an approaching stall?
- How does one raise a low wing in a stall?
- How does one recover from a stall?
- What is meant by the "break" of a stall?
- What are the essential differences of a "power on" and "power off" stall?

15. RECTANGULAR COURSE:

- About how long should the sides of a rectangular course be?
- At what altitude and speed is this maneuver executed?
- What is meant by "crabbing" and why is it necessary?
- Is it necessary to hold rudder when "crabbing"?

16. TAKE-OFFS:

- In what direction do you turn to check traffic before taking off?
- Why is it important to head directly into the wind while taking off?
- If you should see a plane landing while you are preparing to take-off what would you do?
- How is the torque, or rotation of the propeller, compensated for during the take-off and the following climb?
- How high and how far from the field should you be before making your first turn?
- What is the position of the throttle during take-off?

17. 90-DEGREE APPROACH:

- At what altitude should you begin a 90-degree approach to a landing?
- What is your relation to the wind when you start a 90-degree approach for a landing?
- What is the function of the "key position"?
- How can you estimate the velocity of the wind while you are flying along the cross-wind leg of your approach?
- What should you do if you see that you are going to undershoot the field?

18. LANDINGS:

- At what altitude should you start to break your glide for a landing?
- Where should you look during the landing process?
- In case you make a bad bounce during a landing, what should you do?
- What should be done to hold the tail down after the plane is on the ground?
- When is the landing completed?
- In what direction should you turn after landing . . . to taxi back for another take-off or to go up to the hangar?

19. S-TURNS ACROSS A ROAD:

- At what speed and altitude are S-turns executed?
- How do you choose your course for S-turns?
- What is your altitude during this maneuver? Should it ever vary?
- What is the general rule to follow to correct for wind during the turns?

20. 180-DEGREE APPROACH:

- Where is the throttle closed on the 180-degree approach?
- How is the plane headed with respect to the wind when the 180-degree approach is started?
- From what altitude should the 180-degree approach be started?
- How does the velocity of the wind affect your flight pattern in the 180-degree approach?
- Where is the only place the 180-degree "overhead approach" is practiced?

21. SERIES OF EIGHTS (NO. 1 AND NO. 2):

- What is meant by drift? How do you compensate for it in a turn?
- How does one execute the No. 1 or half-eight?
- At what altitude should these eights be executed?
- What is the No. 2 eight and how is it executed?
- Does one need to "crab" in a No. 2 eight? Why?

22. FORCED LANDINGS ON TAKE-OFF:

- What is the first thing to do if your engine stops on take-off?
- How would the direction of your flight path be altered in case of a forced landing on take-off?

23. 90-DEGREE FORCED LANDINGS:

- What is the first thing you do if your engine quits under 500 feet?
- If the ground under you is equally rough anywhere within your gliding range, how should you determine the direction of your landing? Why?

24. NORMAL SPINS:

- What is the first thing you do before starting a spin?
- At what altitude should a normal spin be started?
- In what position are the controls held during a right spin?
- When is the back pressure released in a spin?
- At what minimum altitude should level flight be attained after recovery from spins?

25. ACCIDENTAL SPINS:

- Why are accidental spins demonstrated?
- How should you recover from an accidental spin?
- Name as many indications as you can of an approaching stall.

26. 180-DEGREE FORCED LANDINGS (OVER 500 FEET):

- What is the first thing you do if your engine quits over 500 feet?
- After you have picked out a field, how do you plan your approach?
- What kind of glide do you use?

27. CROSS-WIND TAKE-OFFS:

- Why must you get plenty of speed before taking off cross wind?
- What must you do to keep the plane straight on a cross wind take-off?
- What should you do after you have gained a little altitude?

28. STEEP BANKED TURNS:

- Where should you look before starting a steep banked turn?
- What is the throttle setting for a steep banked turn?
- Is there any over-banking tendency in a steep turn?

29. CROSS-WIND LANDINGS:

- In the approach to a cross-wind landing, how do you keep the plane heading straight?
- After the landing, how do you keep the plane rolling straight?
- What is the difference between the "slip" and "rudder" methods of making a cross-wind landing?
- What is the combination method of making a cross-wind landing?

30. SERIES OF EIGHTS (NO. 3):

How does one begin this maneuver?

What landmarks are used and how are they located with respect to the wind?

Does one need to "crab" in a No. 3 eight? Why?

At what angle does the plane cross the cross-wind landmark?

31. PYLON EIGHTS (ON AND AROUND):

Explain the execution of eights around pylons. Eights on pylons.

32. SERIES OF TURNS:

What is the purpose of a "series of turns"?

At what altitude are they executed?

List in order the turns which make up the series.

Where in the series does one have to "crab"?

What should you do if you discover you have lost 100 feet of altitude in one of the turns?

33. STEEP 720-DEGREE PRECISION TURNS:

What is a 720-degree turn? What is the point of practicing this maneuver?

At what altitude should you start this maneuver?

If you don't feel a "bump" during the second 360-degree turn, what does it mean?

What engine R.P.M. setting is used? Why?

34. SPIRALS:

What is the purpose of a spiral?

What is the proper throttle setting for a spiral? The proper air speed?

What bank should you use in a spiral?

At what altitude should one come out of the spiral?

35. POWER WHEEL LANDINGS:

Under what conditions does one use a power wheel landing?

Describe the approach to a power wheel landing.

At what point in the landing is the throttle closed?

What danger is involved in pushing the stick forward too much or too suddenly?

36. FORWARD SLIPS:

What is the purpose of a forward slip.

What is the throttle setting in a forward slip?

How does one put the plane in a forward slip?

What is the flight path of the plane in a forward slip?

Where is the nose held in a forward slip? Why?

37. SIDE SLIPS:

What is the difference between a forward slip and a side slip?

What is the proper air speed in a side slip?

At what altitude should one recover from a slip?

How is the combination slip executed?

38. "DRAGGING" AREAS:

What is meant by "dragging" areas?

Is this procedure used in case of a motor failure? Why?

At what air speed and altitude does one drag the field?

If the field is sloping and the wind is gentle, would you land up-wind and down-hill or down-wind and up-hill? Why?

How important are the Civil Air Regulations?